an international monthly

THE Petroleum Engineer

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Drilling and Producing | Refining and Gas Processing | Oil and Gas Pipelining

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MAY 1951

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- ☐ SOUR CRUDE
- ☐ SWEET CRUDE

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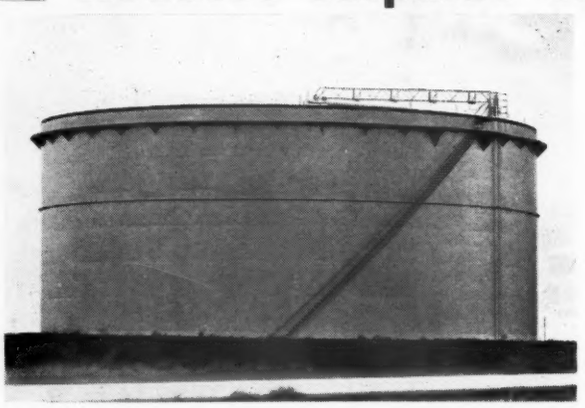
The tank at the right is located at the Luling, Texas, terminal of the Sinclair Products Pipe Line.

☐ Reduces sulphide corrosion



The rapid corrosion on t under side of the roof and ins the shell of a tank storing so crude is due to the action hydrogen sulphide, oxygen a water. If you equip that ta with a Horton Floating Roof, steel deck contacts that liqu over the entire roof area. There no air space in the tank—hen less corrosion.

Left: This tank stores sour crude the Shell Pipe Line Corporation Cushing, Okla., terminal.

☐ Prevents large volumetric losses

The view at the right shows 11 of 16 crude oil tanks in the Gulf Oil Corporation's tank farm near Philadelphia, Pa. Each tank holds 96,000 bbls. and is filled and emptied about 26 times per year.

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THE Petroleum Engineer

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• Drilling and Producing • Refining and Gas Processing • Oil and Gas Pipelining

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HIDDEN OIL

CONFRONTED with mounting costs of discovering and producing oil, and with shortages of critical materials, the industry is called upon to increase substantially our domestic oil reserves. Promising methods of aiding in this objective may be in the offing. At least, that is the prospect if, by improved practice, even a small percentage of our so-called "hidden oil"—the oil that defies recovery by present methods—can be recovered.

Consider mounting costs. In 1950 the unit cost per barrel for oil found was 34.5 per cent greater than in 1949. The unit cost to the producer, for only his share of the oil, was 70.6 cents per barrel in 1950. This includes a drilling cost of 40.3 cents per barrel, and 30.3 cents per barrel for geological, geophysical, lease rentals, and general overhead expense. Compared with a cost of 52.5 cents per barrel in 1949, this is an increase of 34.5 per cent.

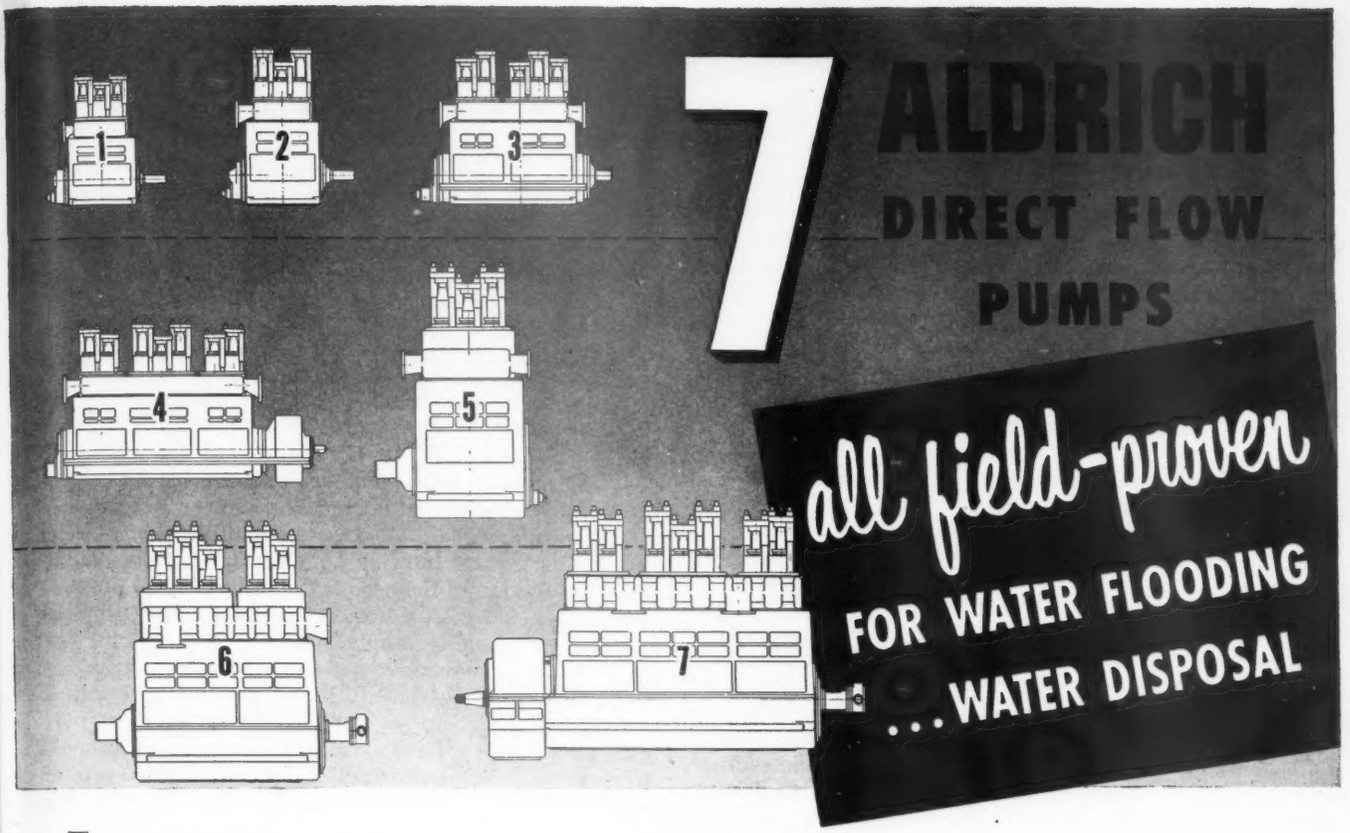
In view of this rapidly rising trend in costs, the dire need for a greater backlog of available domestic oil reserves, and the necessity to make every ton of steel count, attention is called to the work of the Texas Petroleum Research Committee. This committee, unique in its make-up and the first of its kind, was formed in 1947. Three major state agencies—A. and M. College of Texas, University of Texas, and the Texas Railroad Commission, joined forces and pooled their "scientific knowledge and practical experience on the problem of recovering more of this hidden oil" from fields now in production. "The committee was formed to bring together the research facilities of the two state schools and the vast store of information and experience of the Railroad Commission in an organization to seek scientific means to increase the total recovery of oil from Texas fields."

Under the auspices of this committee, the Second Annual Oil Recovery Conference was held last month at College Station. Authoritative papers were presented on carbonate reservoirs in particular and on improving the recovery from reservoirs in general. Notable laboratory and field research in progress promises greater increases in recovery from Texas fields.

Experience indicates that by improving the efficiency of recovery from oil reservoirs, the possibilities are tremendous. Water flooding in the Bradford field, for example, has increased "the primary recovery of oil by 1.7 times." It has been estimated that if present recovery of the original oil in place could be increased by only one per cent "more than one billion barrels" would be added to the world's recoverable oil reserves. In the Bradford field, however, "it is known that some 750 million barrels of high grade crude oil will not be recovered by the secondary methods currently employed."

Beside the Texas Petroleum Research Committee, oil companies are conducting intensive research on this problem of increasing the recovery of hidden oil. There is ample evidence that much of this oil can be made available with a smaller expenditure of steel per barrel of oil recovered than is possible per barrel of new oil reserves.

Considering the magnitude of this source of hidden oil, and in view of the present national emergency, when steel is at a premium, efforts to improve the efficiency of recovery should be intensified.—K.C.S.



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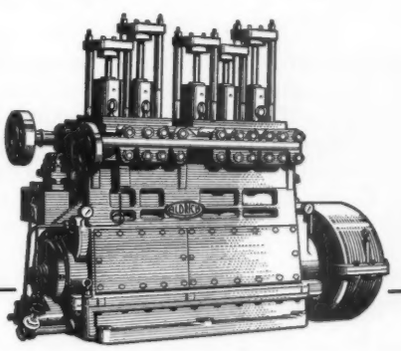

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Scanning WASHINGTON'S OIL HORIZON

★ ★

By MILBURN PETTY

WASHINGTON—Petroleum Administration for Defense is fighting to get the materials for the expanded capacity needed to keep abreast of current civilian and mobilization requirements of oil and gas. Ultimately, PAD will win out, just as PAW did during World War II. But it means a continual battle.

Other agencies must be educated on the enormous size of the industry, its constant growth, and the ever-increasing demands for its products, even without the impact of an all-out war.

From the sidelines, the coal people are sniping at oil and gas expansion. Also, less essential industries are bidding for materials. And the politicians are trying to prevent cutbacks in the manufacture of peacetime items.

▸ **Expansion.** PAD's materials budget for the proposed million-barrel oil expansion program flabbergasted the officials doling out the supply of critical materials.

But, as PAD Deputy Administrator Bruce Brown points out, this is a minimum program to meet foreseeable demands. It contains nothing to provide against the possible impacts of a major war. It takes four years, on the average, to develop an oil field. And refineries cannot be built overnight. So, Brown has warned that there may be shortages of petroleum products if refining capacity is not expanded by at least 700,000 bbl a day by the end of 1952.

▸ **Tax Amortization.** Oil projects certified for accelerated tax write-off under the defense production law total nearly $400,000,000. Most of these were for refining projects, more than half were submitted by independents. There has been pressure on PAD to reduce the percentages being recommended, particularly the 75 per cent for basic refining facilities.

▸ **Tubular Goods.** The controlled materials program begins July 1 with producers allocated enough oil country tubular goods to drill wells at the rate of 44,300 a year (which is less than a hundred more than last year, as PAD points out when it is suggested that the industry is expanding more than necessary). Currently, the drilling rate is 48,000 a year. Requests to PAD for allocations covered enough tubular goods—if granted—to drill at the rate of nearly 75,000 wells a year.

▸ **Equipment.** Questionnaires returned, in a survey of about 500 manufacturers of production machinery and equipment by PAD, indicate that many are having difficulty getting materials. Because machinery is just as necessary to drill as tubular goods, PAD has been pressuring the National Production Authority to set up a special program to take care of these needs. As a result, NPA has put such a program into effect, beginning in June, providing for 34,000 tons of steel to be directed to oil field machinery and equipment manufacturers.

▸ **Line Pipe.** Most serious situation is in line pipe, with production in the first quarter more than 40 per cent below a year ago, mainly because of steel plate shortage.

During World War II, plate production reached 1,300,000 tons per month; today it is about 500,000 tons. Since the war, many mills have converted to making sheet for automobiles, refrigerators, and other such items. No substantial increase in line pipe production can be expected until there is a cutback in such civilian production.

Meanwhile, PAD estimates that the petroleum industry will need 1,374,470 tons of line pipe in the third quarter, broken down, as follows: Oil production, 110,000 tons; oil gathering lines, 22,500 tons; oil trunk lines, 281,700 tons; gas transmission, 740,000 tons; gas distribution, 138,300 tons; gas gathering lines and gasoline plants, 76,250 tons; and liquefied petroleum gas distribution, 5720 tons.

Unless there is an immediate increase in line pipe output, many oil and gas lines will not be completed in time to take over their share of next winter's fuel load.

▸ **Reserves.** Industry representatives were encouraged by the U. S. Geological Survey's praise of the methods used by the American Petroleum Institute and the American Gas Association in determining available reserves of oil and gas.

These figures, said the geological survey in a special report to the Senate Interior Committee, which is conducting an investigation of the need for a national fuels policy, "are impressive and have a firm foundation on a substantial accumulation of reliable data."

Meanwhile, the committee staff is compiling an agenda for formal hearings later this spring. One item sure to be on the list is "adequacy" of petroleum reserves since the coal people are seeking "end use" controls on oil and gas, to promote greater consumption of coal, "the more abundant fuel".

▸ **Supply and Demand.** United States crude production should average 6,065,000 bbl a day, or 12.3 per cent above the 1950 average, to meet expected demands, according to PAD. Imports at the rate of a million barrels daily will also be needed. Gasoline demand is expected to run better than 12 per cent ahead of 1950, with indications that the first quarter was 14.3 per cent higher than last year.

▸ **TEL.** To meet this large increase in gasoline production, there will be about only 85 per cent of last year's supply of tetraethyl lead available for motor fuel. So, octanes must come down. How? That is a problem for the industry to handle, PAD says. Applications for hardship relief under PAD's tetraethyl lead allocation order totaled 235 per cent of the TEL available for supplemental allocations. In parcelling out what's available, PAD may refuse hardship relief to any refiner whose premium gasoline has an octane rating of more than 90 (Research Method).

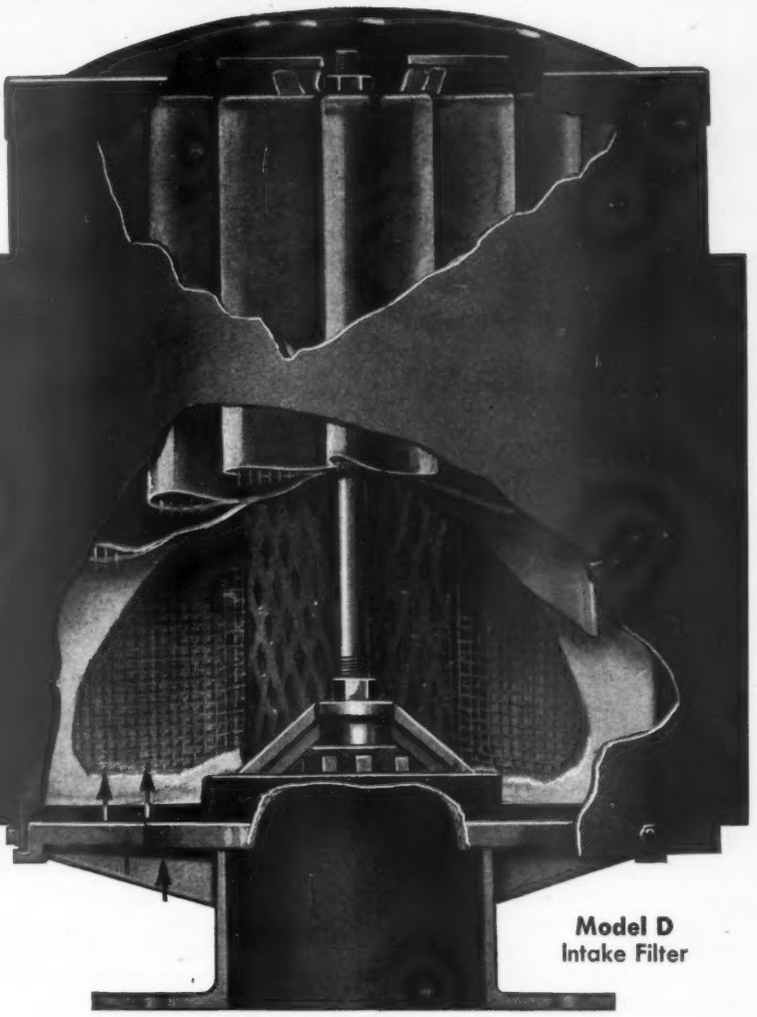
▸ **Tidelands.** Senator O'Mahoney (chairman of the Senate Interior Committee, which is now badly split over a tidelands bill—whether to report the "interim" measure or a quitclaimer) is hoping to snag at least two votes more in the committee so he can send a bill to the Senate floor providing for "temporary" leasing and production authority.

O'Mahoney is counting on these three amendments to the original "interim" bill to gain Senate approval and still ward off a Presidential veto: Limiting Secretary of Interior's authority to issue leases inside the 3-mile limit, with state approval, to a 5-year period; writing in a provision to legalize the California-Federal stipulations, and providing for a federal stipulation as to "inland waters" upon request of any lessee or lessor.

Administration hasn't committed itself to approving these changes but O'Mahoney no doubt will successfully urge Presidential approval if such a bill ever reaches the White House. Complicating all of this, however, is the host of supporters, in both Houses, who are still determined for one more try at enacting a quitclaim bill into law, over Presidential veto, if necessary. And a veto is a certainty if the quitclaim bill ever gets to President Truman.

NOTE:
To Men Responsible
for Engine and
Compressor Operation

THE EFFICIENCY OF STAYNEW INTAKE FILTERS INCREASES WITH USE



Model D
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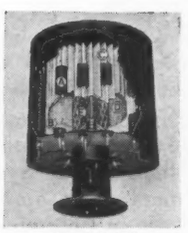

Model DS
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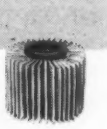
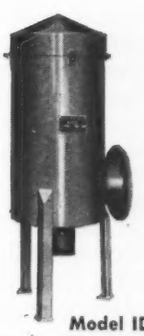
A 12"x12" Staynew Radial Fin Insert Has 2059.2 Sq. In. Active Filtering Area— the same proportion as this panel bears to Insert below

This filtering area in Insert this size.....





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HIGHLIGHTS IN OILDOM

OIL AT 26 FT

Many oil men looking for oil find water, but few look for water and find oil, especially at a depth of only 26 ft. But that was the case of a Mitchell County, Texas, farmer who dug down 26 ft expecting to dig a water well, and came up with an oil well. Rollie C. Bell, owner of the extraordinarily shallow oil well, plans to dig deeper in his search for water. Across the road is the Col-Tex Refining Company plant, probable source for the shallow oil.

NORTH DAKOTA STRIKE

Oil men from all over the United States are flocking to North Dakota as a result of the recent strike made there by Amerada Petroleum Corporation, to give that state its first commercial oil production. The discovery, which is in northwestern North Dakota, confirms the views of many authorities that a more or less continuous production eventually will be proved from Southwestern oil areas of the U. S. far up into Canada. The well is the No. 61 Iverson, which produces oil of 53 gravity, a fact that will help offset its depth, 11,700 ft, which makes development more costly. Production is thought to be from the Devonian limestone, a prolific source of oil in America.

GAS RATES TO CURB DEMAND

Higher rates for natural gas must be granted to curb increasing demand, Stuart M. Crocker, president of Columbia Gas System, Inc., told members of the American Petroleum Institute in Columbus, Ohio, recently. The major increase in the nation's proved reserves, and sharp increases in the price of coal and fuel oil have made gas the cheapest of fuels, Crocker declared. He added that "the resultant jump in demand, along with strict rate regulation has created an artificial price situation."

U. S., RUSSIAN OIL INDUSTRY

Although oil was discovered almost simultaneously in the United States and Russia, the American petroleum industry, under the spur of business enterprise and private ownership has far outdistanced Russia in oil production by a ratio of 8 to 1, Dr. Joseph E. Pogue, petroleum consultant of the Chase National Bank, stated in an address before the American Chamber of Commerce in Rio de Janeiro, Brazil, recently. "Discovered almost simultaneously in the U. S. and Russia, oil has followed at first parallel but eventually divergent courses in the two countries," Dr. Pogue said. "In each, exactly 30 years elapsed before production attained a level of 100,000 bbl daily. For three years, 1898-1901, output in Russia actually exceeded that in the U. S. Then the two paths diverged. Russian production did not regain its 1901 peak until the lapse of nearly three decades, hampered as it was by strikes, riots, the imposition of prohibitive royalties by the government, and finally nationalization.

"This initial parallelism and subsequent divergence emphasizes and contrasts two ways of action—the individualistic and the collectivist. In the United States, individual enterprise continued to be encouraged; in Russia, there was progressive interference by the State and eventually this agency took over entirely," he pointed out.

AN INDEPENDENT OIL INDUSTRY

Public sentiment in support of maintaining our oil industry as an independent industry is needed today even more than it was before the Korean War, C. Z. Hardwick, District Chairman of the Oil Industry Information Committee, declared before the Spring meeting of the production division of the American Petroleum Institute. Hardwick, who is vice president of The Ohio Oil Company, said, "Favorable public attitude toward the industry can do much to withstand the onslaught of permanent or total government regulation clothed in the cloak of crisis."

"A great many people throughout the country are confused and misinformed on very important questions, such as depletion allowance oil-production taxes, etc.," he said, pointing out that oil producers have a tremendous stake in clearing away this confusion and doubt in the public mind.

HIGHEST ROYALTY BID

The highest price ever paid in Oklahoma for oil royalty went to the Velma-Alma school district, recently, when $8575 an acre was paid by Dr. R. H. Safley of Healdton, Oklahoma. Royalties from the school unit, which consists of 2½ acres, brought in $21,437.50 at public auction. A top bid of $6000 an acre had been expected. The Stanolind Oil and Gas Company unit is now pumping 110 bbl per day under the allowable set by the Oklahoma Corporation Commission.

GAS CHEAPER THAN COAL

In a discussion of natural gas prices, S. B. Irelan, Cities Service Gas, has pointed out that it costs $2 to $3 "per inch per mile" to build a pipe line, and E. Buddrus, Panhandle Eastern, cited costs of 6 to 7 cents to transport 1000 ft of gas across Kansas. And, as rates and earnings are fixed by the Federal Power Commission, the transmission companies are forced to sell gas at the end of the line at "just about cost," they pointed out. Buddrus added that the price of gas in Illinois is 25 to 30 per cent cheaper than coal, and in Ohio and Michigan gas is 75 to 100 per cent cheaper than coal.

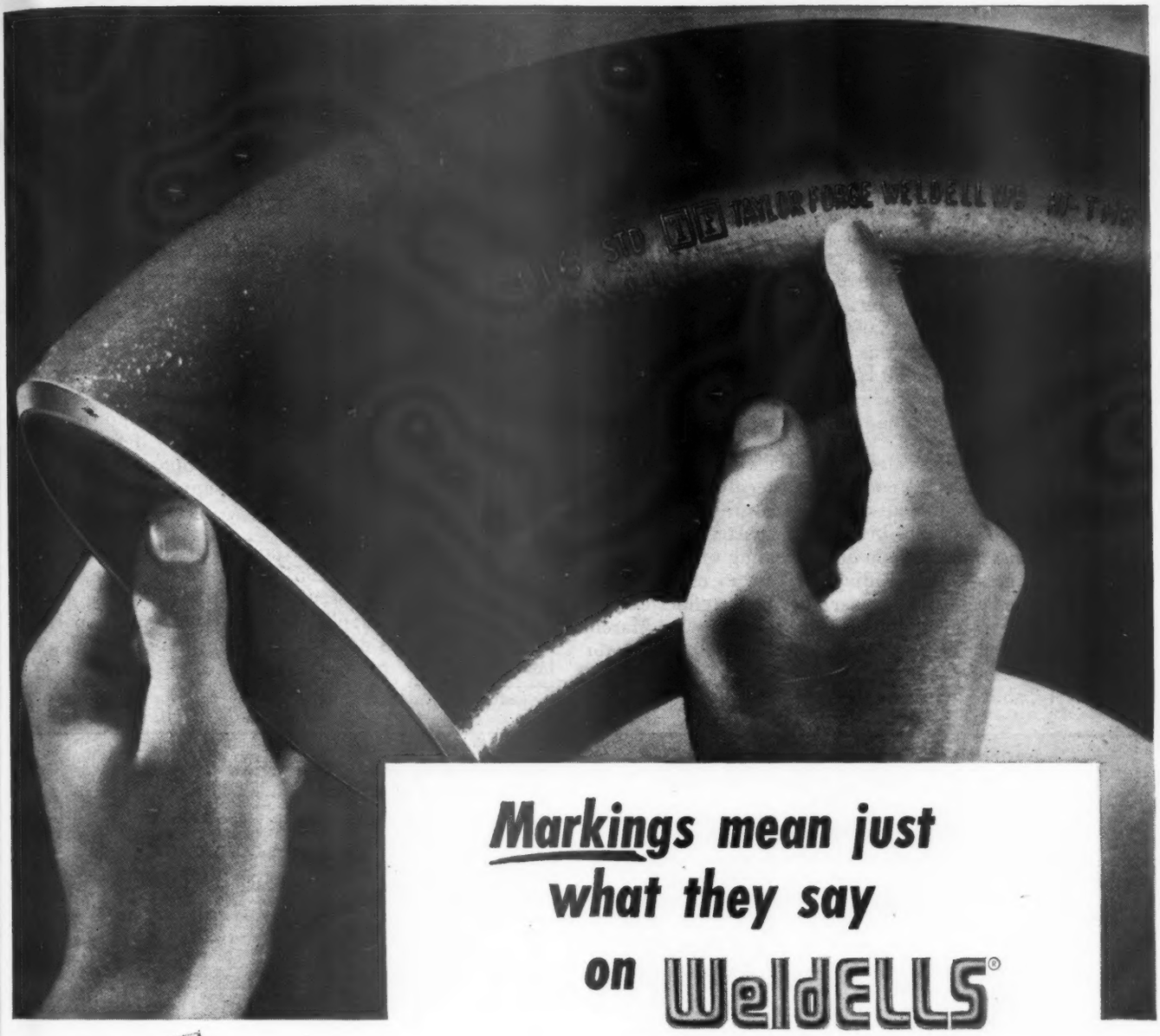
RESERVE FIGURES VARY

In an address to the shareholders of the Union Oil Company of California, Reese H. Taylor, president, stressed the fact that crude oil reserves are not accumulated at anything like a *regular* rate. When a field is discovered, Taylor pointed out, its true worth will seldom show up in the figures of the immediate year or two following the discovery. Then as the field is developed, there will be several years when the estimated crude reserves will increase disproportionately as the extent of the discovery is proved by actual drilling. Moreover, he added, prevailing prices have a material effect on the rate of exploratory and development drilling and on the amount of oil that can be economically produced. As a result, crude reserve figures vary in waves or cycles rather than at a steady, regular, year-to-year rate.

OIL INDUSTRY GROWTH SEEN

Continued spectacular growth of the oil industry, reaching as much as 47 per cent in the decade 1950-1960, has been predicted by H. S. M. Burns, president of Shell Oil Company, in a talk made before the New York Society of Security Analysts. He pointed out that the increase in demand for petroleum products in 1950 was the highest since the end of the war, and foresaw that domestic consumption would go up to between 6,900,000 and 7,100,000 bbl per day in 1951.

Necessary production to meet this demand seems assured, Burns stated, "as long as the oil industry enjoys freedom in its search for oil." Oil alone now supplies approximately 40 per cent of the nation's domestic energy requirements, and natural gas another 16.8 per cent.



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National Petroleum Situation

By H. J. STRUTH*

Production Up 21 Per Cent. National crude oil production in the first quarter of 1951 was 21 per cent above last year. Daily production this year has been at the rate of 5,942,000 bbl, against 4,921,000 bbl in the first quarter of 1950. March production is estimated at a daily average of 6,018,000 bbl, against 4,878,000 bbl a year ago. Texas production in the first quarter was 34 per cent above a year ago, with an increase of 667,000 bbl daily over last year. Heaviest contributors to the production gain were Texas, Oklahoma, California, Louisiana, and Wyoming.

High Demand Rate. Demand for all oils in the first quarter of 1951 was about 14 per cent greater than a year ago. Daily requirements for all products averaged 7,721,000 bbl, against 6,782,000 bbl in the first quarter of last year. An increase in refinery crude oil processing of 20 per cent was reflected in a corresponding increase in crude oil demand of 20 per cent over a year ago. U. S. refineries consumed about 6,418,000 bbl of crude oil daily in March, against a daily average a year ago of 5,336,000 bbl. Motor fuel demand, as well as fuel oil demand were 14 per cent, respectively, above a year ago.

Stock Situation Improved. Stocks of all oils at the close of March were about 1 per cent higher than a year ago. Continued heavy withdrawals of fuel oils from storage in March, more than offset a substantial increase in gasoline stocks, with the result that inventories of all oils were cut below the February 28 level by more than 5,700,000 bbl. This year's increase in supplies has improved the stock situation to the extent that motor fuel stocks are 7 per cent above a year ago, while fuel oil stocks are about 2 per cent above the level of a year ago. That further improvement in the stock picture is necessary, is shown by the relative days supply. This places special emphasis upon stocks of crude oil, which comprise only 35 days' supply, against 44 days' supply last year.

More Domestic Supply. Imports of crude and products in the first quarter of 1951 increased 19.5 per cent over last year. Increase last year over 1949 was 37 per cent. Greater domestic supplies this year have cut import ratio to 11.1 per cent of domestic supply, compared with a ratio last year of 14.7 per cent.

* Petroleum Consultant, Dallas, Texas.

Comparative Statistics, March, 1951

*All figures are computed on a Bureau of Mines' Basis**

	March 1951Ⓟ	Feb. 1951Ⓡ	March 1950	This Year to dateⓅ	Last Year to date	Per Cent change
Total supply,* all oils	232,879	206,688	192,613	670,291	558,223	+20
Daily average	7,512	7,382	6,213	7,448	6,202	
Total demand,‡ all oils	238,492	212,912	216,492	694,911	610,403	+14
Daily average	7,693	7,604	6,984	7,721	6,782	
Change in stocks	—5,613	—6,224	—23,879	—24,620	—52,180	
Crude supply*	203,050	179,100	165,695	580,732	483,959	+20
Daily average	6,550	6,396	5,345	6,453	5,377	
Crude demand‡	206,350	183,321	168,347	593,615	496,217	+20
Daily average	6,656	6,547	5,430	6,596	5,514	
Crude stocks	235,500	238,800	241,098	235,500	241,098	— 2
Days supply	35	36	44	35	44	
Natural gasoline production	16,770	15,280	14,569	49,355	43,251	+14
Daily average	541	546	470	548	481	
Motor fuel production	91,650	83,500	80,786	269,282	236,410	+14
Daily average	2,956	2,982	2,606	2,992	2,627	
Gasoline yield per cent	40.3	40.1	43.5	40.5	43.1	— 2.6
Motor fuel demand‡	86,153	75,050	80,430	243,415	214,196	+14
Daily average	2,779	2,680	2,595	2,705	2,380	
Motor fuel stocks	141,900	136,400	132,632	141,900	132,632	+ 7
Days supply	51	51	51	51	51	
Fuel oil production	84,500	78,500	64,838	249,641	196,365	+27
Daily average	2,726	2,804	2,092	2,774	2,182	
Fuel oil demand‡	103,575	102,941	97,445	321,572	283,174	+14
Daily average	3,341	3,676	3,143	3,573	3,146	
Fuel oil stocks	81,050	87,200	79,637	81,050	79,637	+ 2
Days supply	24	24	25	24	25	
Refinery still runs	198,950	182,200	165,418	581,108	484,242	+20
Daily average	6,418	6,507	5,336	6,457	5,380	
Stocks, all oil	558,090	563,703	550,939	558,090	550,939	+ 1
Days supply	73	74	79	73	79	

Current Crude Oil Prices

U. S. average	$2.58	Louisiana	$2.62
Texas	2.61	Arkansas	2.43
California	2.42	New Mexico	2.40
Oklahoma	2.62	Mississippi	2.23
Kansas	2.62	Illinois	2.76
		Other states	2 60

Basic crude prices:

Oklahoma-Kansas (36 gr.)	$2.57
Texas Gulf Coast (36 gr.)	2.80
East Texas	2.65
West Texas (36 gr.)	2.44
California Signal Hill (26 gr.)	2.31
Pennsylvania, Bradford	4 25

Drilling and Production Statistics

	March 1951Ⓟ	Feb. 1951Ⓡ	March 1950	This Year to dateⓅ	Last Year to date	Per Cent change
Wells drilling	4,860	5,070	4,270	4,860	4,270	+14
Total wells drilled	3,110	2,681	3,181	9,415	9,258	+ 2
Development wells	2,372	2,080	2,531	7,301	7,371	— 1
Oil	1,604	1,399	1,741	4,920	5,096	— 3
Gas	192	191	190	591	560	+ 6
Dry	576	490	600	1,790	1,715	+ 4
Per cent dry	25.3	23.5	23.8	24.5	23.3	+ 1.2
Service wells	57	43	62	149	219	—32
Wildcat wells	681	558	588	1,965	1,668	+18
Oil	117	93	85	335	250	+34
Gas	26	14	17	66	57	+16
Dry	538	451	486	1,564	1,361	+15
Per cent dry	79.0	80.8	82.7	79.6	81.6	— 2.0

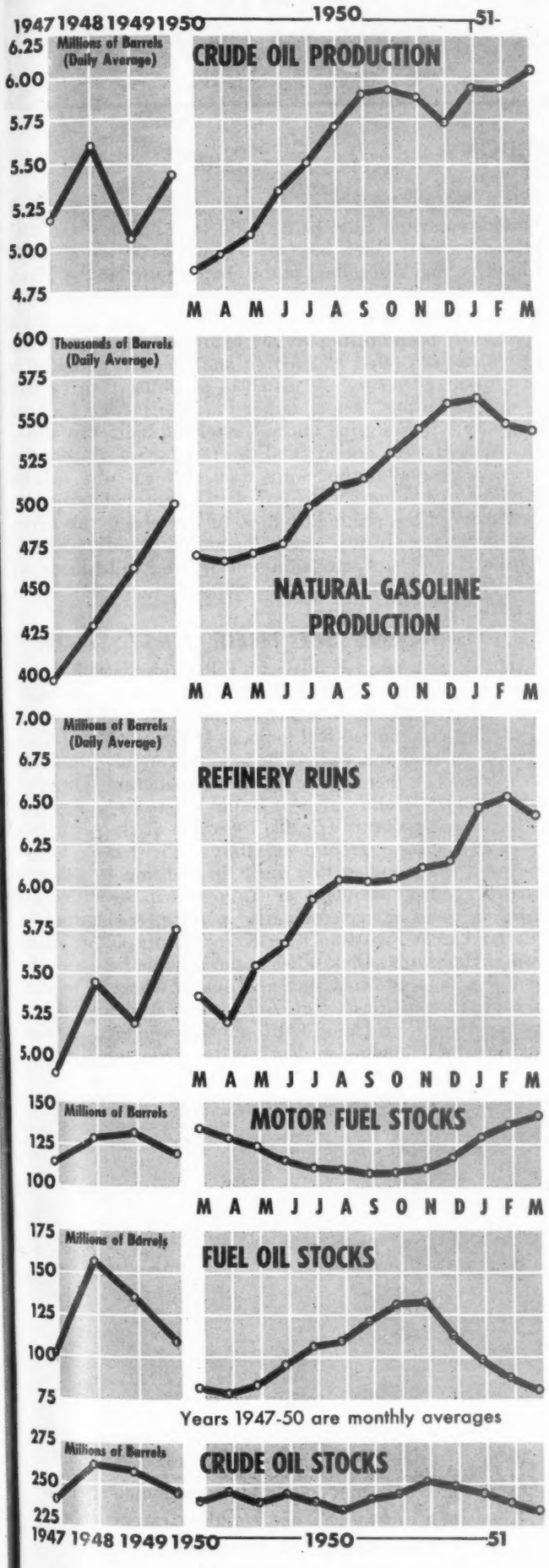
By State

Wells drilled (excl. service)	3,053	2,638	3,119	9,266	9,039	+ 3
Arkansas	25	21	24	94	87	+ 8
California	162	152	122	452	412	+10
Illinois	70	119	156	388	506	—23
Kansas	319	306	293	981	804	+22
Louisiana	166	136	177	492	577	—15
Mississippi	20	17	24	54	73	—26
New Mexico	43	53	52	147	171	—14
Oklahoma	418	358	428	1,272	1,150	+11
Texas	1,335	1,097	1,359	3,901	3,779	+ 3
Other states	495	379	484	1,485	1,480	
Wildcats drilled	681	558	588	1,965	1,668	+18
Arkansas	5	1	3	18	24	—25
California	39	35	34	107	91	+18
Illinois	19	19	38	76	128	—41
Kansas	64	74	49	219	139	+58
Louisiana	29	27	15	82	67	+22
Mississippi	8	11	12	26	28	— 7
New Mexico	9	6	6	27	22	+23
Oklahoma	67	55	74	225	206	+ 9
Texas	337	255	287	909	751	+21
Other states	104	75	70	276	212	+30
Daily crude production	6,018	5,896	4,878	5,942	4,921	+21
Arkansas	80	78	85	80	86	— 7
California	960	961	857	960	863	+11
Illinois	166	136	176	161	171	— 6
Kansas	311	286	290	300	280	+ 7
Louisiana	648	623	535	634	554	+14
Mississippi	103	103	101	104	99	+ 5
New Mexico	142	144	126	141	130	+ 8
Oklahoma	500	504	400	500	402	+24
Texas	2,650	2,588	1,894	2,603	1,936	+34
Wyoming	200	200	163	195	157	+24
Other states	258	273	251	264	243	+ 9

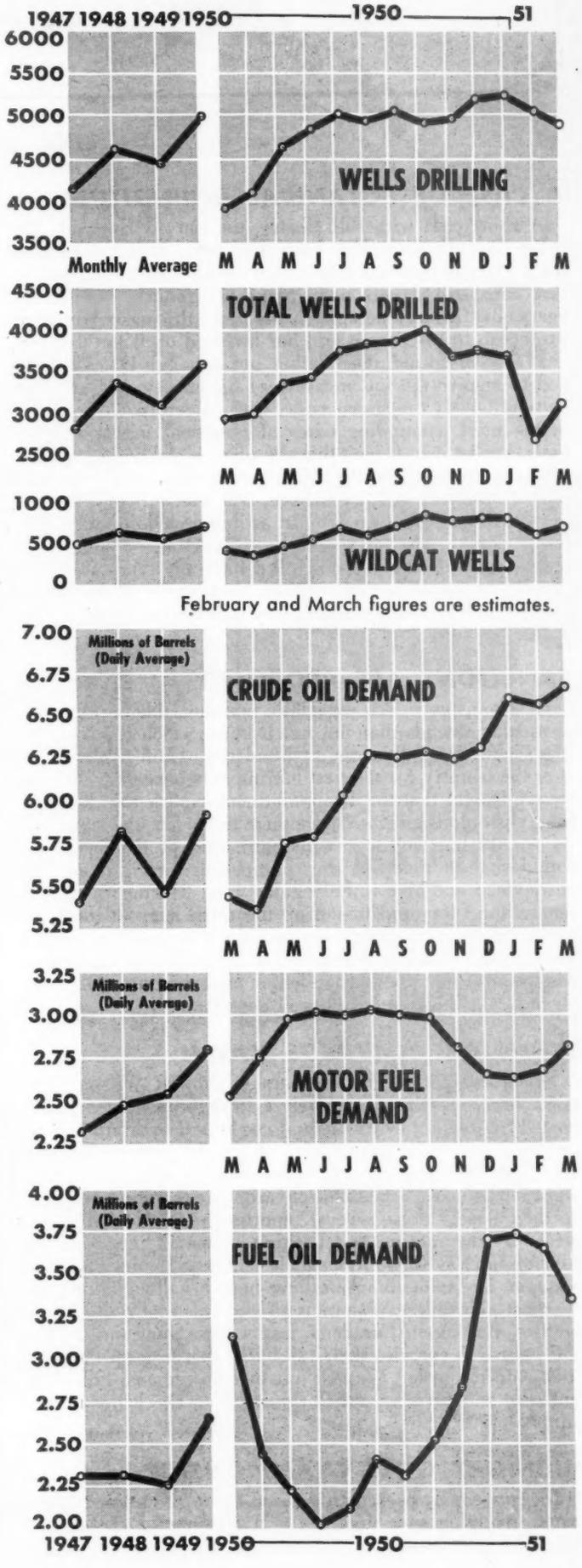
* Unless otherwise stated all figures represent thousands of barrels. ‡ Total demand, including exports. * Includes domestic production and imports. Ⓟ Preliminary. Ⓡ Revised.

Preliminary estimates based upon data supplied by American Petroleum Institute, U. S. Bureau of Mines, State Agencies, and other official sources.

National Petroleum Situation



Years 1947-50 are monthly averages



February and March figures are estimates.

PETROLIC PERSONALITIES

DICK SNEDDON

A CASE OF BOTANICAL INGRATITUDE

A short chat with Bill Heater, the Baroid Burbank, the other day, disclosed the distressing news that the recalcitrant Macadamian nut tree which we have already taken to task here, still refuses point blank to produce. For several years now Bill has metaphorically taken this nasty tempered protacean to his bosom and has lavished on it the extravagant love of an indulgent father but although it has continued to receive the full measure of his affection—and some cultivation—it has given not a whit in return. This is one of the most astounding cases of botanical ingratitude we have ever known. It isn't that the plant is sickly or anything of that sort. Actually, the thing looks strong enough to support a hammock and, by George, if it was ours and refused to contribute to its own support as it is now doing with Bill, that's exactly what it would be supporting—a hammock, and a well loaded one, too! We have no sympathy with plants, or human beings, either, that won't produce and have no more ambition than to laze indolently along through life on the dole.

SANCTIONS ARE PROPOSED

In this instance, it is especially reprehensible because this particular Macadamian nut tree is being watched anxiously, like a newly-wed princess, by hundreds of Bill's friends all over the country for the first inkling of a blessed event, and we are fearful that the disappointment experienced by these kindly people is going to drive them to the left or something. As an old horticulturist with hardening of the heart, we would suggest that Bill stop pampering this ill-mannered antipodean and give it the regular weed treatment. Yank it out by the roots and toss it on the trash heap at the back of the garden. Then, we'll bet four dollars, it will grow like everything, shedding Macadamian nuts all over the place. And, even if that doesn't happen, at least the thing will have been taught the lesson it so well deserves.

WHEN CHURCHYARDS YAWN

Scientists at Cal Tech and up on Mount Wilson have lately been debating ferociously a strange phenomenon, reported by passing motorists and confirmed by a number of people who live in the vicinity of the Annandale Country Club out Pasadena way. It seems that on a recent Friday night at the hour "when churchyards yawn and graves give up their dead," these several reporters were startled all to pieces by the intermittent flashing of small lights out on the club fairway where it parallels Colorado Boulevard. This was seen by far too many to have been a hallucination and the most plausible explanation offered was that a family of fireflies, visiting in Pasadena, might have gone out on the golf course to exercise their tail lights just to keep them in good working order. We had our own suspicions, however, and sent an operative out to the scene to check up on the story.

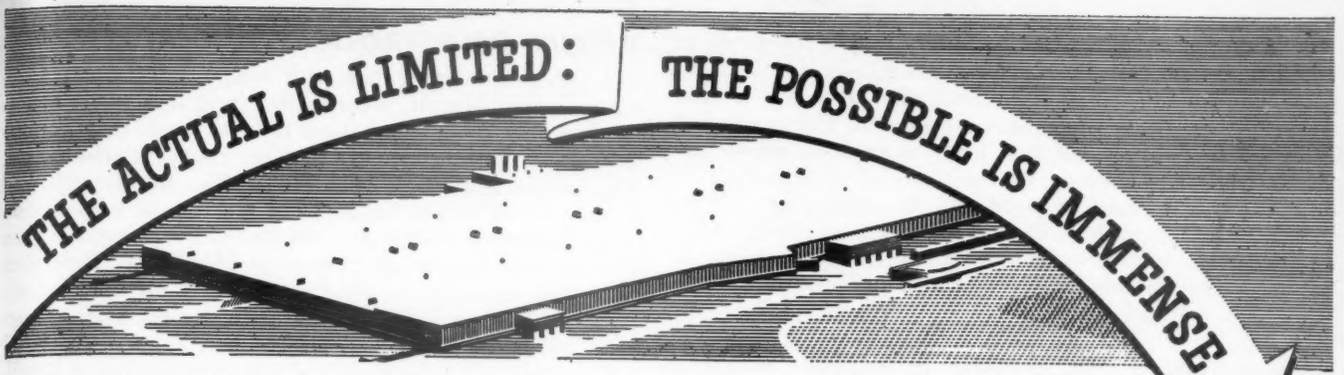
MIDNIGHT GOLF CHAMPIONSHIP

The guy comes back with a weird tale of a midnight golf match involving such notables as Art Donnelly, the distinguished flying horseman; Gil Nesheim, the short but potent Allied Supply Company executive; Hal Detrick, A. O. Smith's contribution to better golf; Josh Baum, Plant Insulation Company chief, head of a weird outfit known as the Chiselers, and descendant of the chap who wrote the Wizard of Oz; and Rolly Lohman who between golf games is a plumbing magnate. Anyway, this divot lofting quintet had apparently been hurling vividly expressed doubts and challenges at each other all evening and eventually took off at 11:30 p.m. on a two-hole match to prove or disprove their several assertions. It was darker than the inside of a black bear when they started out and after the balls were driven from the first tee nobody had the faintest idea where they were, so thereafter they were tracked down with matches and cigarette lighters which, of course, thoroughly squashes the theory of the visiting fireflies. As a sequel to this adventure, Art Donnelly now claims the midnight golf championship of the western petroleum industry and will take on any upstart who dares to contest the claim.

CALIFORNIANS SEE THEIR FIRST SNOW

Had a lunch date recently with Bill Kinder, vice president and manager of Emsco D & B Division, visiting here briefly from Garland, Texas, of which we understand Dallas is one of the larger suburbs. Bill looks as if the climate of Texas agrees with him and, indeed, he is so thoroughly sold on the Lone Star state that he is building a considerable hogan out in the Preston Hollow area of Dallas where he will soon be at home to California friends, especially if they hail from his old stamping ground—Coalinga, the King's County metropolis. Present at this lunch in addition to Bill were Jack Crawford, president of Youngstown Steel Products Company who extracurricularly is the proprietor of the Quarter Circle Five Ranch in Kern County and a sizable herd of Herefords; Dick Whelan, the amiable Irishman, also from the Youngstown Camp and one of whom to be wary in a gin-rummy joust; Ray Zell, the quietly capable purchasing chap from Union Oil Company who can't be quite as young as he looks—we worked in reasonably close con-

That stuff Hugh Glen and Bill Kinder are standing in is snow. They are president and vice president, respectively, of Emsco D & B Division.



NEW LINCOLN PLANT CREATED BY INCENTIVE-INSPIRED CO-ACTION IN DEVELOPING POSSIBILITIES IN PRODUCT

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PUMP BUILDER CUTS WEIGHT 56%

THROUGH welded steel design, the weight of this pump has been cut from 1475 pounds to 650 pounds. The 825 pound saving is especially important since the drilling unit on which the pump is used must be highly mobile.

Designed for operation at 375 psi, the welded construction has eliminated sand holes and surface blemishes as well as uneven metal distribution of cast parts. A cost analysis shows also that the pumps are being produced at substantial savings.

Typical of the trend in the oil industry, greater durability to withstand severe service is creating a decided preference for welded steel construction by many customers.

Welding Mud End Assembly *of slush pump using simple fixture to locate steel component parts with close fit up for fast downhand welding.*

Welded Steel Pump *for well drilling operations built by George E. Failing Supply Company, Enid, Oklahoma. Light in weight . . . easy to move around. Has rounded corners for "modern" appearance.*

FOR SIMPLER DESIGN

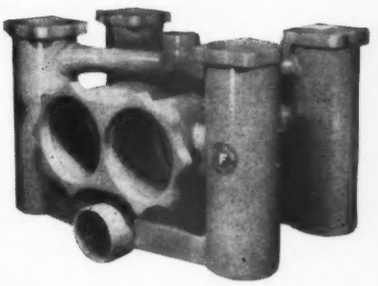

Fig. 1. Mud End Assembly *is produced from thin wall cold drawn tubing, fillet welded into a single, rugged assembly to withstand severe service in the field.*

REQUIRES LESS MATERIAL

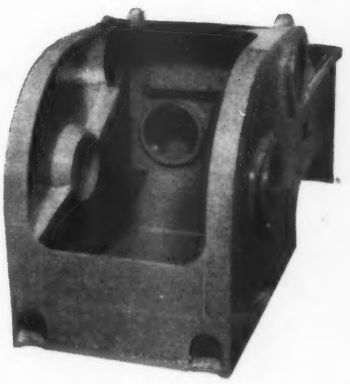

Fig. 2. Power End Housing *for pump is simply fabricated from plate. Bearing bosses are steel tubing fillet welded to walls with "Fleetweld 5" electrode.*

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cert with him some 25 years ago and he looked just the same then; and last, Tiny Bush, who is Bill Kinder's very pleasant but very substantial right hand man. Bill tells us that when he and Hugh Glen, Emsco president, first arrived at Garland in February of this year, he thought maybe the plane had taken a wrong turn and landed at Winnipeg. It was snowing a junior blizzard and the whole place was as white as a slot machine magnate who has just received a subpoena from the Kefauver Committee. The snow, of course, was extremely interesting to this pair of Californians who never see such stuff excepting in pictures.

CONQUEROR OF FINNY GIANTS

We have always envied the chaps who devote their talents to the search for oil in foreign lands and we never miss an opportunity to talk to them when they are around. It was thus our good fortune not too long ago to chat briefly with W. B. "Bus" Hayes, a Healdsburg, California, boy who has spent the past 13 years in foreign service and is now drilling superintendent for International Petroleum Company at Talara, Peru. Bus began his oil career at Huntington Beach with Union Oil Company in 1919, later worked in the same area with Standard, and then switched over to Continental for 11 years, more or less. He shipped to Colombia as drilling foreman for Tropical Oil Company in 1938, was in due course transferred to Peru in the same capacity for International, shortly thereafter was made assistant drilling superintendent and then superintendent, the post he now occupies. Bus is a widely known, well liked chap who has done a lot for American oil men visiting in South America and in consequence when he comes back to the U. S. for a rest he is so besieged with invitations that rest becomes more strenuous than work. In Peru his spare moments are devoted to deep sea fishing for tuna, swordfish, and other finny giants, and we understand that down yonder any catch weighing less than 110 lb is regarded as undernourished and is tossed back into the drink to develop a bit.

VICTIM OF PETROLIC WANDERLUST

Another interesting lad with whom we conversed recently is Loyd Marolf, just returned from Iran where he was employed by Drillex and about to leave for Ethiopia in the interests of the Sinclair Oil Company about the time we met him. Loyd was born in Deep Water, Mo., but by 1922 had managed to get out to California. For a time he worked with the old Petroleum Midway Company at Torrance, and then tried a first foreign assignment at Maracaibo. Returning from that he stayed in the United States for the next ten years, but the wanderlust was not to be denied. After garnering a varied experience in drilling techniques he took off to Venezuela again for Gulf, and has since worked in Brazil, Paraguay, Iran and goodness knows where else.

PITCHED FOR PITTSBURGH PIRATES

Another recently returned Argentinian is W. H. "Buck" May, scion of a noted pioneer oil family, and native of the bustling village of Bakersfield. Buck worked for many years in the San Joaquin Valley for Standard of California, Tide Water Associated, The Texas Company, and other producing concerns and had a lot of experience tucked under his belt before he attached himself to Drillex in 1949 as a toolpusher for a tour of service in the Argentine. He came back early this year from that assignment and is probably by this time down in Venezuela doing a stint for Santa Fe Drilling Company. He is a former big league baseballer—pitched with Pittsburgh Pirates in 1924 and also put in a couple of seasons with the San Francisco Seals. Personally, we have never been able to make the baseball team although we have long been rcognized as a pretty sharp performer behind the plate—the dinner plate, that is. Buck proudly claims that about 1948 when he was working for Dunlap and Graham on a Continental well, his crew ran 80 stands of drill pipe and put the kelly on in 58 minutes, which he still thinks is a historical performance.

YACHTSMAN STEERS FOR CANADA

Comes now late word that O. I. "Tork" Torkelsen, vice president of British American Oil Producing Company's western division, has been transferred to Toronto, Canada, as coordinator of exploration and production. Tork is a collegiate looking chap who hails originally from Minnesota but struck out for the west early enough to complete his education at the University of California. From this noted institution he graduated with a degree in geology and promptly attached himself to the Reiber Geophysical Company. Following two years with this organization he began operation as a consultant in Los Angeles and had quickly acquired substantial assignments in California, Texas, and New Mexico. He began work with British American in 1939 as a geologist and has since steadily climbed to the position of vice president. Outside of work Tork finds keen pleasure in yachting and another strange nautical pastime, known as ship, captain, and crew. He is well liked out on the coast and he and his pretty wife are going to be badly missed by the many Angelenos who have come to know them as friends.

HEROIC EFFORT TO CLARIFY SITUATION

By way of last minute news, we are told that at the North Texas Oil and Gas men's annual meeting at Wichita Falls, operators and contractors indulged in a prolonged discussion of pipe procurement. How to make application for it and, having made application, what are the chances of getting it, were the two main items of debate. Our Wichita Falls operative tells us that while the questions remain unanswered, the heroic efforts of two gentlemen, namely, Brian Payne and Jerry Vinson, to unravel the tangled skein of red tape in which pipe allocation is enmeshed, were worthy of the highest commendation.

DATA ON IMPORTANT OIL FIELDS OF THE UNITED STATES

No.	Year discovered	Field	County	Producing formation	Gravity °API	Productive acres	Estimated Average thickness (feet)
				ALABAMA			
1	1944	Gilbertown	Choctaw	L. Tuscaloosa	19.0	1,120	—
				ARKANSAS			
1	1938, 43	Atlanta	Columbia	Reynolds, Cotton Valley; Jur.	41.5-44.0	2,040	30
2	1937	Buckner	Lafayette, Columbia	Reynolds; Jur	32.0	1,680	30
3	1927	Champagnolle	Union	Tokio, Hosston, Blossom, Meakin, Graves; Cre	22.0-33.0	2,000	15
4	1939, 42	Dorcheat-Macedonia	Columbia	Reynolds, Cotton Valley; Jur.	43.0-67.0	4,640	83;25
5	1922	El Dorado, East	Union	Nacatoch; Cre U	20.5	1,380	10
6	1920, 21	El Dorado, South	Union	Nacatoch; Cre U	33.0	7,740	20
7	1921, 36	Irma-Troy	Navada	Tokio, Nacatoch; Cre U	14.1-22.0	2,100	27
8	1925	Lisbon	Union	Nacatoch; Cre U	34.0	2,640	15
9	1938, 43	Magnolia	Columbia	Cotton Valley, Reynolds; Jur.	38.0-42.0	4,240	10; 100
10	1940, 42	McKamie	Lafayette	*Cotton Valley, Reynolds; Jur.	58.0	2,740	106
11	1942	Midway	Lafayette	Reynolds; Jur	36.0	1,640	75
12	1937	Rodessa	Miller	Rodessa; Cre L	39.0-45.0	2,300	25
13	1937, 41, 42	Schuler, and Schuler, East	Union	Cotton Valley, Reynolds, Jones Sand; Jur	34.0-47.0	4,390	42
14	1922, 36	Smackover	Union, Ouachita	Nacatoch, Graves, Tokio, Meakin; Cre U	19.0-36.0	29,500	50
15	1922, 41, 45	Stephens	Columbia, Ouachita, Nevada	Buck Range, Tokio, Glen Rose, Hosston; Cre	23.0-32.0	3,180	20
16	1929	Urbana	Union	Nacatoch; Cre U	19.0-33.0	780	12
				CALIFORNIA			
		San Joaquin Valley					
1	1912	Belridge, North	Kern	Etchegoin, Temblor, Vaqueros; Mio, Pli	33.0-44.0	2,600	625
2	1911	Beldridge, South	Kern	Etchegoin, Temblor; Pli, Mio.	16.0-24.0	5,200	50
3	1909	Buena Vista	Kern	San Joaquin, Etchegoin; Pli.	26.6	12,500	50
4	1944	Buena Vista (Sec. 27)	Kern	Etch 1 and 2	30.0	4,000	45
5	1937	Canal	Kern	Stevens; Mio	37.5	900	225
6	1900, 38	Coalinga, East Side, incl Oil City	Fresno	Etch, Temblor; Pli, Mio	21.0	6,100	17
7	1939	Coalinga, Northeast	Fresno	Avenal; Eoc	28.0	1,200	130
8	1938	Coalinga, Nose	Fresno	Avenal; Eoc	33.0	3,200	360
9	1901	Coalinga, Westside	Fresno	Etch, Sta Margarita; Mio, Pli.	15.8	9,500	180
10	1938	Cole's Levee, N	Kern	Stevens; Mio	36.0	2,700	320
11	1938	⊕Cole's Levee, S	Kern	Stevens; Mio	35.0-44.0	3,700	300
12	1927	Coffee Canyon	Kern	Vedder; Mio	16.0	350	60
13	1934	Edison	Kern	Kern River; Pli. Vedder; Mio.	18.5	2,500	125
14	1919	Elk Hills	Kern	San Joaquin Clay, Etch, Stevens	18.5-33.0	18,500	75-400
15	1928	Fruitvale	Kern	Etchegoin, Chanac	19.8	1,800	88
16	1936	Greeley	Kern	Stevens, Vedder	38.5	2,100	290
17	1941	Helm	Fresno	Temblor; Eoc	19.0-34.0	3,300	25
18	1941	Jacalitos	Fresno	Temblor; Mio	40.0	1,200	15
19	1915	Kern Front	Kern	Etchegoin; Pli	14.4	4,000	80
20	1899	Kern River	Kern	Kern River; Pli	13.3	6,900	130
21	1928	Kettleman, N. Dome	Fresno, King	Temblor, Avenal; Mio, Eoc	36.5	16,600	850
22	1910	Lost Hills	Kern	Etchegoin; Pli	22.0	2,000	80
23	1887, 1945	McKittrick	Kern	Etchegoin; Pli, Mio	14.2-36.0	1,750	350
24	1901	Midway-Sunset, (all pools incl Santiago)	Kern	Etchegoin, Maricopa; Pli	17.1	17,500	65
25	1934	Mountain View	Kern	Chanac, Sta Margarita	26.0	1,800	55
26	1926	Mount Poso Dist	Kern	Vedder; Mio	15.4	2,800	150
27	1939	‡Paloma	Kern	Stevens; Mio	35; 51	5,200	200
28	1943	Pleasant Valley	Fresno	Avenal; Eoc	29.5	582	200
29	1929	Poso Creek Dist	Kern	Vedder; Mio	13.7	1,600	35
30	1941	Raisin City	Fresno	Eoc	30.0	800	10
31	1937	Rio Bravo	Kern	Vedder; Mio	38.5	1,950	220
32	1941	Riverdale	Fresno	Mio, Eoc	35.0	2,050	35
33	1927	Rd Mtn Group (excl Coffee Canyon)	Kern	Jewett-Vedder; Mio	16.5	1,590	66
34	1936	Ten Section	Kern	Stevens; Mio	35.0	2,060	200
35	1938	Wasco	Kern	Shale, Vedder; Mio	32.0-39.0	220	45
36	1923	Wheeler Ridge	Kern	Pli, Mio	22.0	260	600
37	1942	Williams	Kern	Mio	16.0	280	—
		Coastal District					
38	1929	Capitan	Santa Barbara	Vaqueros; Mio. Sespe; Olig	28.0	200	135
39	1908	Cat Canyon	Santa Barbara	Sisquoc; Mio	13.5	1,800	Fis
40	1940	Del Valle	Los Angeles	Modelo; Mio	32.0	500	107

*Reynolds abandoned 1944 (Cotton Valley only)
⊕Includes condensate of approximately 3000 M bbl cumulative to 1-1-48.
†Includes Cymric, much enlarged after 1944.
‡Includes condensate of approximately 7000 M bbl cumulative to 1-1-48.

From The Petroleum Data Book, Second Edition, which carries 750 pages of information on the petroleum industry.

DATA ON IMPORTANT OIL FIELDS OF THE UNITED STATES

No.	Annual production (thousands of barrels)						Cumulative production thru 1947 (M bbl)	Estimated recovery per acre (bbl)	Number wells producing		
	1942	1943	1944	1945	1946	1947			Total	Flowing	Pumping
						ALABAMA					
1	0	0	43	181	380	385	989	539	—	—	—
						ARKANSAS					
1	1,304	955	1,165	1,334	1,587	1,490	9,392	3,874	53	36	17
2	762	661	665	611	542	631	6,506	3,497	41	4	37
3	270	247	235	247	221	231	16,362	8,066	78	3	75
4	1,024	779	2,359	1,749	1,446	1,465	10,921	2,038	113	106	7
5	114	189	144	126	116	110	10,124	7,257	37	0	37
6	375	318	295	297	269	266	50,176	6,448	142	0	142
7	591	555	496	469	505	449	12,070	5,534	159	0	159
8	60	52	51	47	53	50	7,077	2,662	132	0	132
9	6,366	6,001	5,591	4,960	4,717	4,649	50,632	10,845	109	94	15
10	722	365	1,104	1,097	1,059	1,175	6,493	1,941	21	21	0
11	1,222	2,170	2,376	2,638	2,640	2,689	13,736	6,736	44	35	9
12	368	213	196	201	192	197	7,607	3,222	52	1	15
13	5,720	5,512	5,103	4,722	4,404	3,944	56,196	11,903	116	56	60
14	4,893	4,458	4,262	4,143	4,067	3,950	414,778	13,926	16	4	12
15	619	1,564	1,838	2,044	1,883	1,474	16,218	4,636	355	0	355
16	916	699	547	407	299	290	9,388	11,664	60	0	60
						CALIFORNIA					
	San Joaquin Valley										
1	1,947	2,129	2,343	2,326	1,954	1,867	56,293	20,933	71	—	—
2	954	2,374	3,982	4,614	3,907	2,621	41,505	7,484	508	—	—
3	5,296	5,278	5,119	4,912	4,725	4,370	311,847	24,598	945	—	—
4	0	0	1,770	10,861	10,031	12,894	35,556	5,666	—	—	—
5	1,060	1,446	1,296	1,241	867	739	13,247	13,898	34	—	—
6	5,234	7,069	8,001	7,564	6,225	5,774	261,302	41,890	720	—	—
7	3,489	4,085	3,930	3,408	2,914	3,127	25,452	18,604	—	—	—
8	8,465	17,977	20,772	17,803	17,498	19,232	115,486	30,079	—	—	—
9	2,102	2,216	2,657	2,863	2,509	2,440	160,856	16,675	—	—	—
10	4,349	4,790	5,770	6,100	5,676	6,112	37,449	11,606	100	—	—
11	1,032	1,109	925	1,020	780	1,114	10,202	2,456	40	—	—
12	798	676	566	471	426	—	—	35,371	—	—	—
13	1,006	892	1,036	2,168	5,307	4,124	22,854	7,492	261	—	—
14	4,363	5,373	7,722	15,767	3,669	2,334	196,965	10,521	138	—	—
15	2,269	2,543	3,028	3,062	2,723	2,391	40,367	21,101	179	—	—
16	2,594	4,827	5,216	5,061	3,923	4,288	32,300	13,339	94	—	—
17	80	167	500	1,202	1,579	1,553	5,085	1,070	57	—	—
18	57	118	227	1,175	1,623	1,681	5,119	2,865	81	—	—
19	2,409	2,663	3,195	3,151	3,237	3,250	65,466	15,554	639	—	—
20	2,667	3,095	3,478	3,536	3,589	3,728	297,781	42,616	2,370	—	—
21	13,018	15,290	15,135	14,351	13,849	13,480	337,321	19,508	305	—	—
22	1,382	1,322	1,272	1,223	1,313	1,922	59,747	28,912	527	—	
23	1,782	1,712	1,793	2,059†	5,239	7,176	111,132	59,975	483	—	—
24	15,108	14,929	15,120	14,441	15,318	15,660	720,860	40,297	2,811	—	—
25	1,763	1,390	1,159	1,021	1,369	1,890	49,100	26,156	144	—	—
26	8,002	8,350	7,960	6,673	5,930	5,151	95,885	32,405	519	—	—
27	272	297	1,229	1,614	3,417	1,816	—	1,556	—	—	—
						3,221	—	—	—	—	—
28	0	235	943	1,305	1,306	1,500	5,289	6,510	21	—	—
29	—	1,502	1,695	1,500	1,297	1,325	11,797	6,545	—	—	—
30	302	381	927	1,156	986	963	4,779	4,773	37	—	—
31	3,575	5,443	5,921	5,758	4,883	4,576	42,899	19,653	90	—	
32	91	601	1,524	1,542	1,481	1,546	6,791	2,559	49	—	—
33	3,887	3,448	3,334	3,020	2,926	2,709	39,820	23,340	286	—	—
34	4,805	6,558	4,624	4,095	3,229	2,829	41,731	18,884	—	—	—
35	450	779	823	501	270	92	4,635	20,650	—	—	—
36	99	94	91	85	84	79	4,453	16,823	—	—	
37	91	751	674	676	575	—	—	9,882	—	—	—
	Coastal District										
38	844	1,178	1,080	792	1,265	1,091	11,897	54,030	65	—	—
39	1,039	1,152	2,532	2,963	2,965	4,424	34,995	16,984	130	—	—
40	516	928	1,474	2,044	2,353	3,069	11,106	16,074	—	—	—

(Continued next month)

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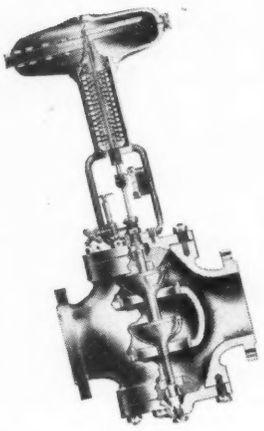

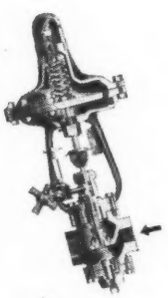

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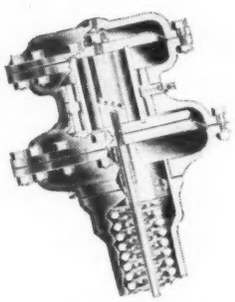

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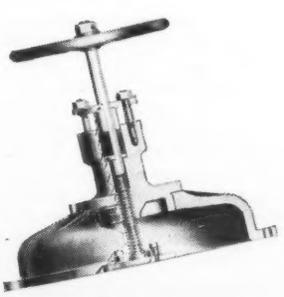

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LETTERS *to the* EDITORS

Discoverer of Cuyama

To The Petroleum Engineer:

I am greatly amazed at a statement by Mr. Richard Sneddon in his article, "A Look at the California Oil Industry" (November, 1950, Page A-37.) After developing a thesis about the kind of people who make discoveries of new oil fields, in which he seems to be trying to lead up to the idea of how natural it was that the Richfield Oil Corporation should have discovered oil in the Cuyama Valley, he gets around to the statement:

> *"One of the most interesting California discoveries of recent years is Cuyama, . . . in which Richfield Oil Corporation has been definitely the party of the first part."*

This statement is definitely wrong. All well informed people know who discovered oil in the Cuyama Valley, and the prime discovery by the Norris Oil Company, with George Hadley, an enterprising old man in his seventies, as its geologist, is recognized in all official publications of the State of California and informed publications of the oil industry and newspapers of the area surrounding the Cuyama, including those at Bakersfield, Taft, Santa Maria, and Ventura. There was only one pioneer discovery, made January 1, 1948, by the Norris Oil Company at the foot of White Rock Bluff, and Richfield's determination to drill was evidently not made before that date. They did not get drilling started until about four months later . . . The discovery well which gave impetus to the development of the valley and led to Richfield's well publicized program, gave quite a convincing show as a producer, starting out with a flow of about 250 barrels per day of clean oil, and produced from the Santa Margarita sand for nearly a year, after which, on being deepened, it has established itself as a successful well . . .

Mr. Sneddon's appraisal of the kind of people who find new oil fields needs revision so far as this case is concerned, where no major oil interests and no scientific geologists gave help worthy of mention, or even moral support, while over a period of years more than 20 wells were drilled in vain and a few people with common sense and practical understanding eventually proved that there was oil where major companies and their geologists predicted none. It was told after the discovery that geologists on meeting each other exchanged as greetings an old Indian Sign, in which they lifted the right hand, placed the left hand over the eyes, and said with somewhat of a moan, "Cuyama! Cuyama!"

Halvern L. Norris

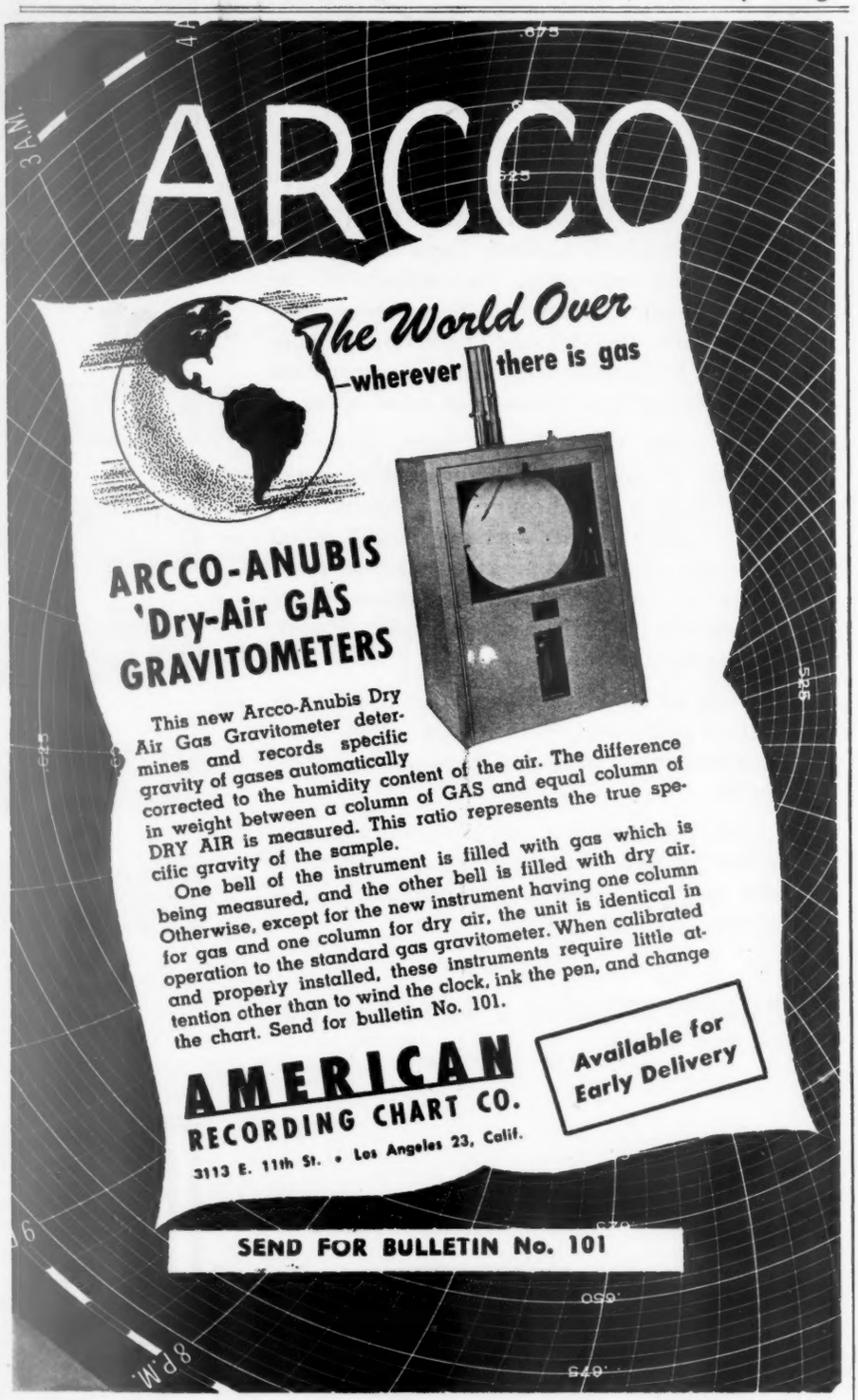
Norris Oil Company
Ventura, California

Editor's Note:

With respect to Mr. Norris' letter, it is quite true that he drilled the first producing well in Cuyama Valley, a fact with which I was thoroughly familiar at the time I wrote the article in question.

I should point out, however, that I was not writing the story of Cuyama but was merely trying to highlight in the limited space of two pages significant events so far as the California oil industry at that moment was concerned.

I dislike to take the credit away from Mr. Norris or any other pioneer operator but I still believe in all fairness that the significant find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in Cuyama Valley was Richfield's strike in the Diblee sand. There is no question, of course, that the Norris Oil Company's prior efforts stimulated that discovery too, but the quantity of oil produced from the Margarita sand in the meantime has made little impression on the status of the California oil industry, whereas Diblee production has been a consequential factor in a great many ways.

I note that another Cuyama well has been recently completed in the Margarita sand and I hope for the sake of Mr. Norris that many more will be brought in, so that eventually through sheer preponderance of quantity he will receive the recognition he deserves.

My respects to the Norris Oil Company, drillers of the first producing well in Cuyama, and if even unwittingly I have created another impression, herewith my profoundest apologies!

—R. Sneddon

What's Right!

To The Petroleum Engineer:

I have received a copy of the advance proof entitled "What's Wrong With Being an Oil Company?" by Ernestine Adams. I think this is a fine "new angle" approach to cover the "rich oil man" emotional type publicity that has been pointed at the petroleum industry during the last few years. My only comment is that, fine as The Petroleum Engineer magazine is, this article should go into a magazine that has national distribution such as The Saturday Evening Post or perhaps Reader's Digest. I hope that an effort will be made so that its full impact will be felt where it will do the most good.

J. Ed Warren

King, Warren, and Dye
Midland, Texas

Wants Reprints

To The Petroleum Engineer:

I have been fortunate enough to see a proof of the article, "What's Wrong With Being an Oil Company," and feel that Miss Adams is to be complimented very highly on her rebuttal of all the criticism which has been directed against the oil companies.

I would like to have fifty copies of this article for distribution, and would appreciate your informing me how I may obtain them.

Paul S. Benedum

Hiawatha Oil and Gas Company
Pittsburgh, Pennsylvania

Editor's Note: *Copies of the article are obtainable upon request.*

Steel for Deep Wells

To The Petroleum Engineer:

Can you tell me about how much steel is used in completing today's deep oil wells?

Warren Hoffman,

Centralia, Ill.

Editor's Note: Although it is difficult to tell how much drilling rig steel is used per well drilled, the amount of steel used in a completed oil well, that is, left on the location, is about as follows for wells of the given depths:

Depth of well, ft	Item	Total weight of steel, tons
4000	oil string	40.0
	surface pipe	25.0
	tubing	10.0
	rods	3.0
	wellhead & fittings	2.0
	pumping unit, etc.	5.0
		85.0
8000	oil string	100.0
	surface pipe	25.0
	intermediate pipe	50.0
	tubing	25.0
	rods	6.0
	wellhead & fittings	5.0
	pumping unit, etc.	15.0
		226.0
12000	oil string	160.0
	surface pipe	25.0
	intermediate pipe	100.0
	tubing	40.0
	rods	10.0
	wellhead & fittings	10.0
	pumping unit, etc.	25.0
		370.0

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THE Petroleum Engineer

May, 1951

EXCLUSIVE

One-third *of* Income *for* Exploration

Oil-finding costs rose to new high level in 1950 — It costs five times as much as it did in the pre-war years 1935-37.

H. J. STRUTH*

Oil producers in the United States spent one-third of their gross income from crude oil in 1950 in exploration for new sources of oil supply. Expenditures in the search for oil reserves in 1950 aggregated $1,439,350,000, which comprised 33.4 per cent of the total working interest market value of all the crude oil produced during the year. Production of crude oil in 1950 totaled 1,971,845,000 bbl. The value of this oil, after deducting royalty interests, amounted to $4,299,114,000.

Replacement costs of oil reserves in the United States rose to a new high level in 1950, when initial finding costs averaged 70.6 cents per bbl. This compares with an average finding cost in 1949 of 52.5 cents per barrel, and a pre-war, 1935-37, average cost of only 13 cents per barrel. These figures represent only the cost of finding oil in the underground reservoirs. They do not include costs incurred in the development of oil production, nor the cost of producing oil in established oil fields.

Depletion of oil fields makes necessary the continued, unrelenting search for new sources of oil supply. The facts prove, however, that the replacement of oil reserves today is costing the oil industry over five times as much as it cost to find oil in the pre-war years 1935-37. Furthermore, capital expenditures involved in exploring for new oil reserves are nearly seven times greater than those incurred in 1935-37. Average annual expenditures for exploration in the last three years, 1948-50, were $1,276,730,000, compared with annual expenditures in 1935-37 of $187,648,000.

While the oil industry drilled in 1950 the greatest number of exploratory wells in its history, the results, from the standpoint of reserves discovered, were not commensurate with expenditures of capital and effort. Exploratory drilling activity was nearly 16 per cent more than in 1949, while reserves discoveries credited to this activity amounted to 15 per cent less than in 1949. At the same time, expenditures for exploration were 14 per cent greater. Efforts of oil men to locate new, proved reserves in 1950 attained new heights, when 16,249 exploratory wells were drilled. This compares with 14,025 such wells drilled in 1949. These are wells drilled in the search for new oil reserves, including all dry holes drilled in exploration and in the development of previously discovered fields.

New petroleum liquids reserves

*Petroleum consultant, Dallas, Texas.

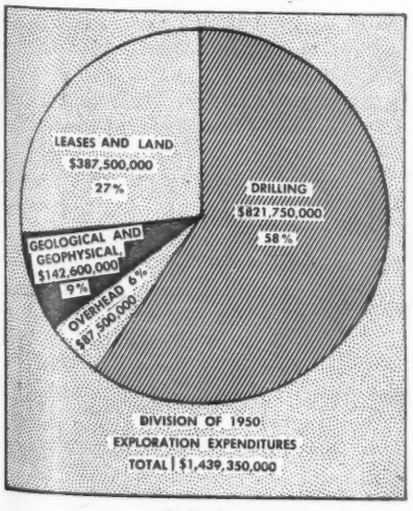


FIG. 1

TABLE 1. 1950 petroleum exploration expenditures.

(Preliminary estimates)

	Total cost	Cost per bbl (net working interest)
Drilling cost	$821,750,000	$.403
Cost of carrying leases	387,500,000	.190
Geological, geophysical, and land department	142,600,000	.070
Overhead and general office	87,500,000	.043
Total	$1,439,350,000	$.706
Exploratory wells drilled (1)	16,249	
Drilling cost per well (2)	$ 50,572	
Total cost per well	$ 88,600	
New reserves discovered (bbl)		
New fields and new pays	623,099,000	
Extensions to previous discoveries	1,759,391,000	
Total (3)	2,382,490,000	
Working interest (85.5%)	2,037,028,000	
Initial finding cost	$.706	

(1) Includes wildcat oil producers and all dry holes drilled
(2) Includes cost of equipping producing wells
(3) Excluding revisions in previous estimates of 946,257,000 bbl.

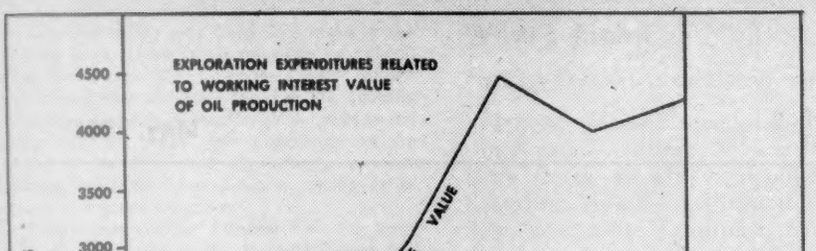


FIG. 2

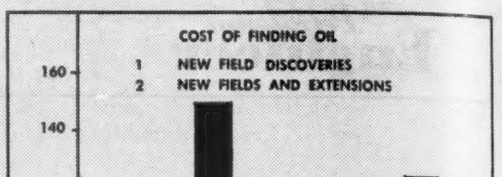


FIG. 3

credited to the year 1950 were estimated to have aggregated 3,328,747,000 bbl, according to studies recently completed by the Joint Committee on Reserves of The American Petroleum Institute and The American Gas Association. This compares with the Committee's estimate in 1949 of 3,574,621,000 bbl, and a total in 1948 of 4,265,764,000 bbl. These totals include all oil reserves added by new field discoveries, extensions to previously discovered fields, and by revisions in previous estimates. A breakdown of these estimates indicates that about 946,000,000 bbl credited to 1950 represented revisions in previous estimates. This means that the quantity of new reserves found in new fields, and by extensions to older fields, aggregated about 2,382,000,000 bbl, compared with a corresponding credit in 1949 of about 2,798,000,000 bbl.

About 58 per cent of the money spent for exploration in 1950 was charged to drilling exploratory wells. The average cost per well, including equipment of producing wells, amounted to $50,572. The cost of carrying leases, geological, geophysical, and overhead expenses is estimated to have aggregated about $617,000,000, and comprised about 42 per cent of the total expenditures. The addition of these costs to the cost of drilling operations brought the total average expenditure per well to $88,600. In the last three years, the average expenditure per exploratory well drilled in the United States has amounted to about $88,823. This compares with an average cost in 1935-37 of about $32,578 per well.

The rise in costs of exploratory operations of the oil industry is indicated by the relative average expenditures per well. Increased labor and equipment costs, as well as materially higher lease rental payments, have increased expenditures per exploratory well by about 172 per cent since 1935-37. Thus, for every dollar incurred in drilling such wells in the pre-war period, it now costs $2.72. While crude oil prices have increased during this period, from $1.08 per barrel to $2.56 per barrel, it is necessary today to drill 2½ times as many wells as formerly, in order to maintain an adequate back-log of reserves. The oil industry used to find quite a few 100,000,000 bbl oil fields, which were classed as major discoveries. Today, however, despite the more intense search for oil, with 2½ times as many exploratory wells drilled, a majority of the new oil fields discovered fall far below the rating of "major" discoveries. Oil is harder to find today, and it requires far greater effort and expense to maintain the margin of reserves needed to meet the growing future demand for petroleum.

In the face of the facts cited here, it is difficult to understand how the oil industry could be expected to accept a reduction in the statutory depletion allowance. Administration of-

TABLE 2. Cost of exploration and value of oil produced.

Year	Gross crude production (thousand bbl)	Working interest (85.5%) (thousand bbl)	Average price	Value of working interest (thousand $)	Exploration expenditures (thousand $)	Per cent of working interest value
1944	1,677,904	1,434,608	$1.20	$1,721,530	$ 517,659	30.1
1945	1,713,655	1,465,175	1.20	1,758,210	731,207	41.6
1946	1,733,939	1,482,518	1.39	2,060,700	826,186	40.1
1947	1,856,987	1,587,724	1.92	3,048,430	904,332	29.7
1948	2,020,185	1,727,258	2.59	4,473,598	1,135,476	25.4
1949	1,841,940	1,574,859	2.54	4,000,142	1,255,367	31.4
1950	1,971,845	1,685,927	2.55	4,299,114	1,439,350	33.4
7 years	12,816,455	10,958,069	$1.95	$21,361,724	$6,809,577	31.8

TABLE 3. Cost of finding oil in new fields by wildcat drilling (extension drilling excluded).

	1947	1948	1949	1950	Total 4 years
New reserves found (Mill)	505	461	983	623	2,572
Working interest (Mill)	432	394	840	533	2,199
Discovery wells drilled	660	783	880	980	3,303
Dry holes drilled	3,750	4,437	4,635	4,855	17,677
Total wells drilled	4,410	5,220	5,515	5,835	20,980
Drilling and equipment cost (thousand $)	374,860	443,700	479,805	504,700	1,803,065
Other costs (1) (thousand $)	114,034	143,881	150,860	156,500	565,275
Total cost (thousand $)	488,884	587,581	630,665	661,200	2,368,340
Initial cost per bbl	$1.13	$1.49	$ .75	$1.24	$1.08

(1) Includes leases, geological, geophysical, and overhead costs.

TABLE 4. Cost of exploration and oil finding cost in the United States.

Years	Initial Reserves found* (a)	Working interest* (85.5%)	Revised reserves found* (b)	Working interest* (85.5%)	Exploratory wells drilled (c)	Drilling cost (Thousand $)	Other costs (Thousand $) (d)	Total cost (Thousands $)	Initial cost per bbl	Revised cost per bbl	Cost per well: Drilling	Cost per well: Total
1944	1,243	1,063	2,148	1,858	7,503	$240,479	$277,180	$517,659	$.487	$.278	$32,051	$68,994
1945	1,581	1,352	2,569	2,196	8,187	365,557	365,650	731,207	.541	.332	44,650	89,313
1946	1,635	1,398	2,457	2,100	9,403	420,386	405,800	826,186	.591	.393	44,708	87,864
1947	1,892	1,618	2,823	2,544	10,401	481,982	422,350	904,332	.559	.355	46,340	86,947
1948	2,270	1,941	2,663	2,278	12,850	602,575	523,901	1,135,476	.585	.499	46,890	88,364
1949	2,798	2,392	3,105	2,655	14,025	696,622	558,745	1,255,367	.525	.473	49,670	89,505
1950(p)	2,382	2,037	—	—	16,249	821,750	617,600	1,439,350	.706	—	50,570	88,600
					(Three-Year Moving Averages)							
1935—37	1,637	1,449	2,431	2,078	5,760	67,318	120,330	187,648	.130	.090	11,687	32,578
1936—38	1,848	1,635	2,662	2,276	6,161	75,277	132,624	207,901	.127	.091	12,218	32,745
1937—39	1,744	1,543	2,480	2,120	6,525	83,779	146,834	231,613	.150	.109	12,840	35,496
1938—40	1,441	1,275	2,311	1,976	6,607	88,836	157,154	245,990	.193	.124	13,446	37,232
1939—41	1,150	1,018	2,040	1,744	6,969	101,696	170,820	272,516	.268	.156	14,593	39,104
1940—42	919	813	1,844	1,578	6,750	111,351	173,519	284,870	.350	.181	16,496	42,303
1941—43	876	775	1,701	1,454	6,679	133,644	196,696	330,340	.426	.227	20,010	49,459
1942—44	964	853	1,822	1,558	6,717	174,083	228,890	402,973	.472	.258	25,917	59,993
1943—45	1,231	1,089	2,155	1,843	7,464	257,027	295,820	552,847	.508	.300	34,435	74,068
1944—46	1,486	1,315	2,391	2,044	8,364	342,141	349,543	691,484	.526	.338	40,906	82,698
1945—47	1,702	1,506	2,616	2,237	9,330	422,642	397,933	820,575	.545	.367	45,299	87,950
1946—48	1,932	1,652	2,647	2,263	10,884	501,647	453,683	955,330	.578	.422	46,086	87,765
1947—49	2,320	1,984	2,864	2,449	12,428	593,726	504,665	1,098,391	.553	.448	47,785	88,402
1948—50	2,483	2,123	—	—	14,374	706,982	569,748	1,276,730	.601	—	49,043	88,823

(a) Oil found in new fields and extensions to previous discoveries.
(b) Revisions in previous estimates allocated to original discovery years.
(c) Wildcat oil wells and all dry holes drilled in exploration and development.
(d) Includes lease, geological, geophysical, and overhead costs.
(p) Preliminary.

*Millions of barrels

ficials in Washington, who contend that the depletion allowance is a "tax loophole" and that the rate should be reduced to 15 per cent, instead of 27½ per cent, apparently recognize the need for some allowance, which they have arbitrarily placed at 15 per cent. What they probably do not realize is the fact that the oil industry is actually expending 33.4 per cent of the gross value of crude oil in its search for new reserves. In the last seven years, the oil industry spent $6,809,577,000 for exploration, which comprised 31.8 per cent of the working interest value of all the crude oil produced during that period. Any reduction in the depletion allowance would obviously discourage oil operators and would necessitate retrenchment in exploration activities. Nothing should be permitted to interfere with the efforts of oil men to continue their vigorous search for new oil reserves, particularly during these critical times, when oil is so vital to the welfare and defense of our nation.

Many persons outside of the petroleum industry do not realize the tremendous sums of capital required to find a new oil field. The public hears about a new oil strike, and visualizes "liquid gold." The public does not hear about the many, costly dry holes that are drilled each year in the search for new oil fields. In the last 4 years, for example, it was necessary to drill on the average 5¼ dry holes to locate one producing oil well in a new, unexplored area. That means 84 per cent of the wells drilled in new territory were dry holes. The cost of such wells, including drilling, equipment, leases,

FIG. 4

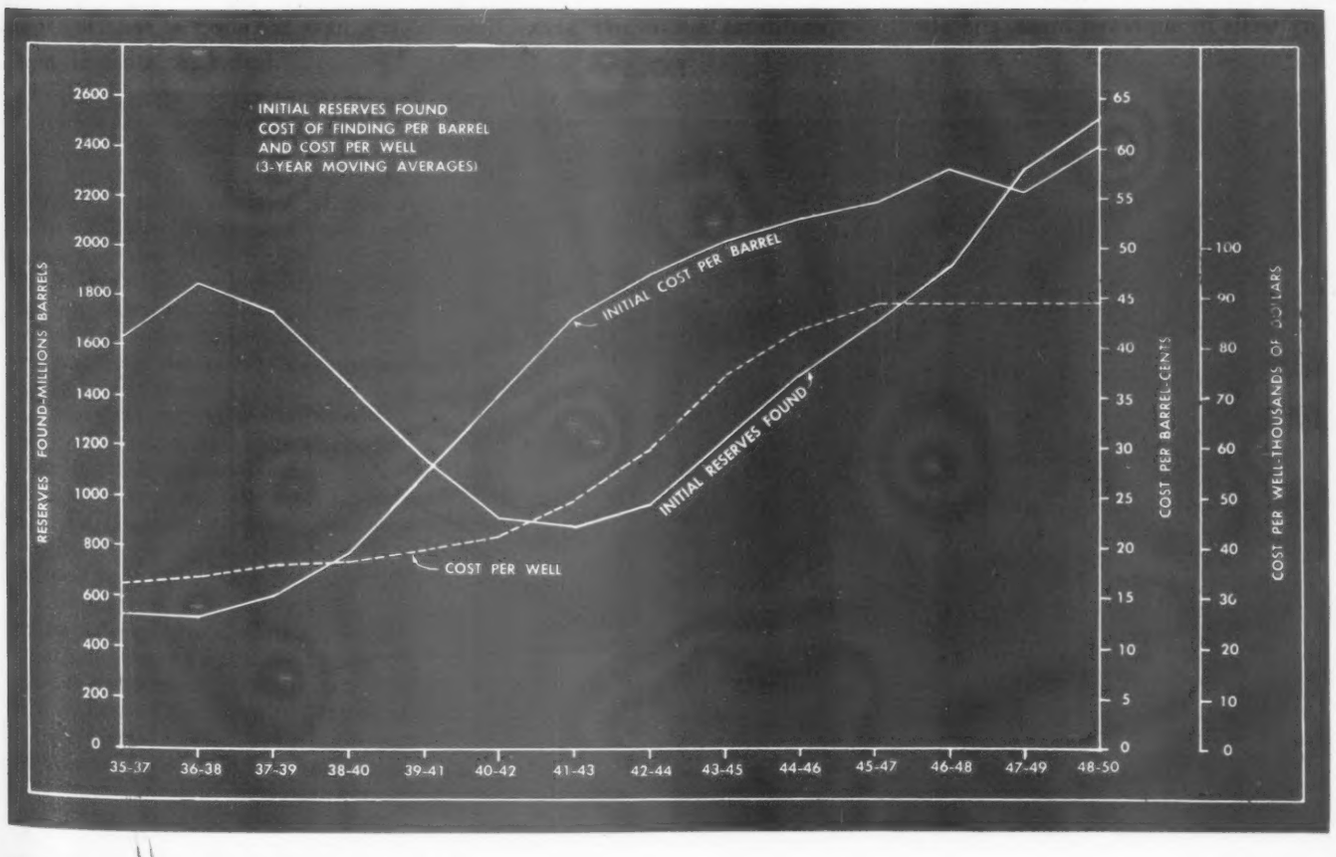


TABLE 5. Trend of reserves discoveries per exploration cost dollar.

Period	Annual expenditures	Total annual discoveries* (barrels)	Reserves found per dollar spent in exploration (barrels)
1935–37.....	$187,648,000	1,637,000,000	8.7
1936–38.....	207,901,000	1,848,000,000	8.9
1937–39.....	231,631,000	1,744,000,000	7.5
1938–40.....	245,990,000	1,441,000,000	5.9
1939–41.....	272,516,000	1,150,000,000	4.2
1940–42.....	284,870,000	919,000,000	3.3
1941–43.....	330,340,000	876,000,000	2.7
1942–44.....	402,973,000	964,000,000	2.4
1943–45.....	552,847,000	1,231,000,000	2.2
1944–46.....	691,484,000	1,486,000,000	2.1
1945–47.....	820,575,000	1,702,000,000	2.1
1946–48.....	955,330,000	1,932,000,000	2.0
1947–49.....	1,098,391,000	2,320,000,000	2.1
1948–50.....	1,276,730,000	2,483,000,000	1.9
Year 1950...	1,439,350,000	2,382,000,000	1.6

* Initial reserves found through new fields and by extensions to previously discovered fields.

geological, geophysical, and overhead expenses, averaged about $112,000 each. As it was necessary to drill 6¼ wells, of which only one was a producer, the cost incident to the discovery amounted to about $700,000. Relatively few oil operators could afford such expenditures without the 27½ per cent depletion allowance.

The cost of finding oil in unproven areas is believed to have exceeded $1.00 per bbl in the last four years. The writer's studies indicate that the cost of reserves found in new fields in 1950 was approximately $1.24 per bbl. In the last four years the average cost has been about $1.08 per bbl. In 1950, the industry drilled 980 discovery wells in unproved areas, and also drilled 4855 dry holes in the effort to locate new fields. The cost of these operations, including drilling, leases, geophysical, geological and overhead, amounted to about $661,200,000. New reserves credited to these operations amounted to 623,000,000 bbl, or a net working interest of 533,000,000 bbl, making the average cost $1.24 per barrel.

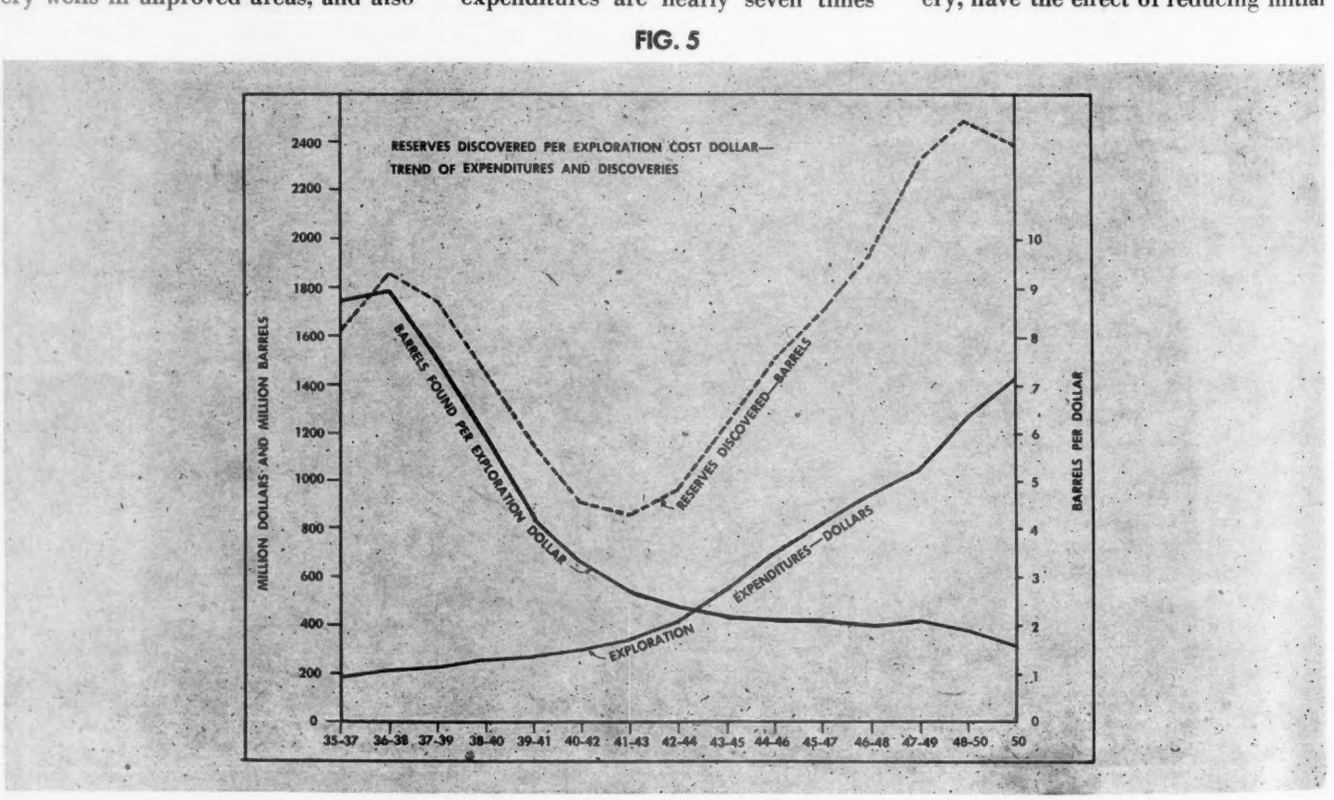
A break-down of oil finding costs for the year 1950 indicates an average cost of oil discovered by extension drilling of about 51 cents per bbl. The average cost of all new reserves found in 1950, by new field and extension drilling was 70.6 cents per bbl. Allocation of expenditures to new field exploration and extension drilling operations places the cost of wildcat wells, in unproved areas, at an average of $112,000 per well, while the cost of all other exploratory drilling amounted to an average of $74,000 per well. About 46 per cent of the money spent for exploration is chargeable to new field drilling, while 54 per cent is consumed in extension drilling operations. A major share of the cost of drilling more than 15,000 dry holes in 1950 is chargeable to exploration, since practically every dry hole drilled represents exploratory effort, either to find a new field, extend the limits of older fields, or to locate new production horizons in established fields.

Highly significant to the petroleum industry, as well as to those who would reduce the industry's depletion allowance, is the fact that while exploration expenditures are nearly seven times greater than in the pre-war period 1935-37, exploration results have diminished to only one-fifth of those attained in the pre-war period. The most effective demonstration of this is shown by the fact that in the three years, 1935-37, the oil industry found an average of 8.7 bbl of reserves for each dollar spent for exploration, while in the last three years, 1948-50, discoveries averaged only 1.9 bbl of new reserves discovered for each dollar spent for exploration. These facts make it clear that a constantly greater share of the industry's returns from crude oil must be spent each year to maintain the nation's petroleum reserves at an adequate level.

The cost of finding oil is measured primarily by dividing the total expenditures incurred in exploration by the quantity of new oil reserves discovered initially in new fields and by extensions to previously discovered fields. The actual cost to the producer, however, is the dividend after deducting royalty oil, which is cost free. In 1950, the net discoveries of crude oil amounted to 2,037,000,000 bbl, which involved exploration expenditures of $1,439,350,000. The initial finding cost, therefore, was 70.6 cents per bbl. Estimates of the Joint Committee on Reserves indicated a decrease in the quantity of oil found in 1950, which resulted in an increase in the unit oil finding cost of about 18 cents per barrel.

Revisions in previous estimates of reserves discoveries, when allocated back to the years of original discovery, have the effect of reducing initial

FIG. 5



unit costs of finding oil. Such increments have had the effect, for example, of reducing the initial finding cost in 1935-37 from 13 cents per bbl to 9 cents per barrel. Back credits of revisions in initial estimates increased discoveries from an average of 1,637,000,000 bbl to an ultimate credit of 2,431,000,000 bbl. During the six-year period, 1944-49, such credits resulted in an average downward revision in initial finding costs of about 15 cents per barrel. The average finding cost during the three-year period, 1947-49, based upon original estimates, amounted to 55.3 cents per barrel. Subsequent revisions in original estimates reduced the average cost to 44.8 cents per bbl. Upward revisions in estimates compiled by the Committee on Reserves, and included in the total discovery credits to the year 1950, amounted to about 946,000,000 bbl. This quantity has been allocated to several prior years, in accordance with the author's method of crediting such oil to original discovery years. The results are believed to represent a more accurate conception of oil finding costs.

Over a period of 15 years, 1935 through 1949, annual credits for revisions in previous estimates have added about 38 per cent to the reserves discoveries originally credited to new fields and extensions. Projection of this experience would indicate the probability that ultimate discoveries credited to the year 1950 may be in the order of about 3,280,000,000 bbl. The ultimate effect of such credits may reduce 1950 oil finding costs to about 55 cents per barrel.

While subsequent revisions in annual reserves discovery estimates reduce initial oil finding costs, it usually takes about eight years to realize the full effect of such revisions. The compilation of 3-year moving averages of discoveries and costs shows that the maximum reduction in initial finding cost amounted to 22 cents per bbl in 1942-44, while credits due to 1950 revisions had the effect of reducing average costs about 11 cents per bbl between 1947-49. Ascending cost ratios must necessarily be considered in projecting the probable effect of future revisions upon initial oil finding costs. The important point now is the fact that it cost the oil industry 70.6 cents for each bbl of new reserves initially discovered in 1950.

The price of crude oil has a highly important bearing upon the course of exploration activity. During the war years, when oil prices were pegged at relatively low levels, exploration activity levelled off, and reserves discoveries declined to a relatively low level. After the war, when price ceilings were removed, oil prices advanced and were accompanied by a sharp increase in exploratory drilling, which resulted in a material increase in reserves discoveries. In the last three years, the price of crude oil has averaged $2.56 per bbl, which spurred exploratory drilling to a new high level of 14,374 wells, and increased average annual reserves discoveries to 3,723,000,000 bbl. During the war years, when the price of crude oil averaged $1.16 per bbl, an average of only 6715 exploratory wells were drilled, which resulted in annual reserves credits of 1,526,000,000 bbl. Since the war period, exploratory drilling has increased 114 per cent; crude prices have advanced 122 per cent; reserves discoveries have increased 130 per cent.

Constantly rising costs of exploration have created a growing disparity between the relative dollar values of crude oil prices and oil finding costs. While the crude oil market dollar of 1935-37 has advanced to a relative level of $2.37, the dollar cost of finding oil has increased to a relative level of $4.61. In the pre-war period, when the average price of crude oil at wells was $1.08 per bbl, the initial cost of finding a bbl of new reserves was 13 cents. In the last three years, when crude oil was selling for $2.56 per bbl, oil finding costs have averaged 60.1 cents per bbl. Meanwhile, for every dollar the oil industry spent for exploration in 1935-37, it must now spend an equivalent of $6.82.

TABLE 6. Exploratory wells drilled, reserves discovered, and price of crude oil.

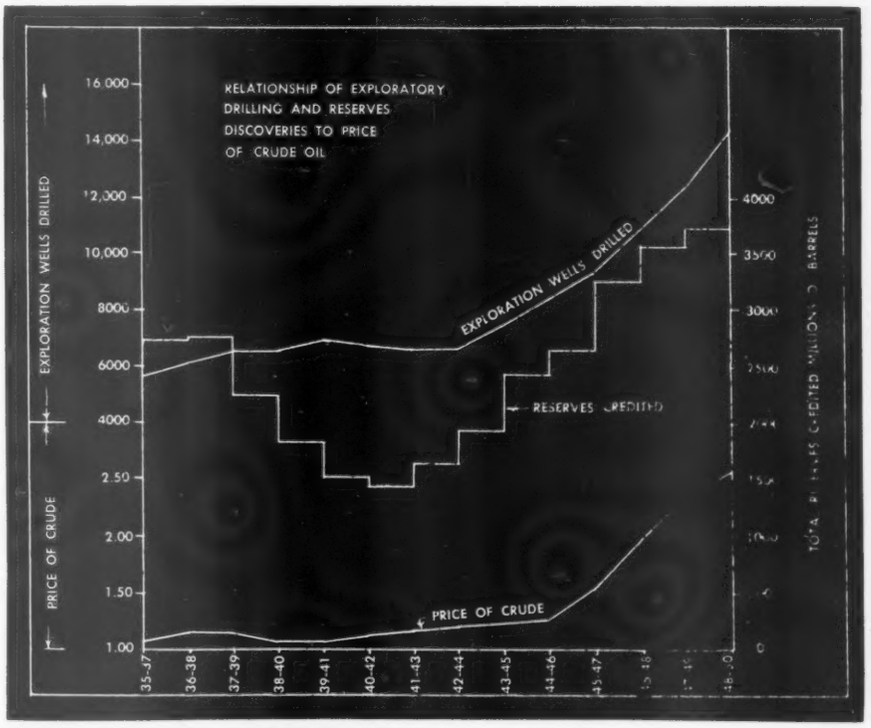
(3-Year moving averages)

Period	Exploratory wells drilled	Total reserves credited* (Million bbl)	Price of crude oil
1935–37	5,760	2,220	$1.08
1936–38	6,161	2,731	1.13
1937–39	6,525	2,794	1.11
1938–40	6,607	2,248	1.05
1939–41	6,969	1,807	1.06
1940–42	6,750	1,509	1.11
1941–43	6,679	1,442	1.17
1942–44	6,717	1,629	1.20
1943–45	7,464	1,929	1.21
1944–46	8,364	2,425	1.28
1945–47	9,330	2,634	1.52
1946–48	10,884	3,286	1.97
1947–49	12,428	3,518	2.35
1948–50	14,374	3,723	2.56

* Including oil found in new fields, extensions and revisions in previous estimates.

Calculations based upon reserves information provided by the Joint Committee on Reserves indicate a decidedly favorable situation with respect to future availability of petroleum. Since 1935, the nation's proved reserves of petroleum liquids have increased from 14,492,000,000 bbl, to an estimated total at the close of 1950 of 29,606,000,000 bbl. Meanwhile, the number of producing oil wells in the United States has increased to 460,200, compared with a total in 1935 of 340,990 wells. Currently, the average quantity of reserves available per producing well is about 64,332 bbl. In 1935, the quantity of reserves available from each producing well was only 42,500 bbl. The consistent growth in quantity of available reserves per well is highly important to the nation's welfare, both from the

FIG. 6



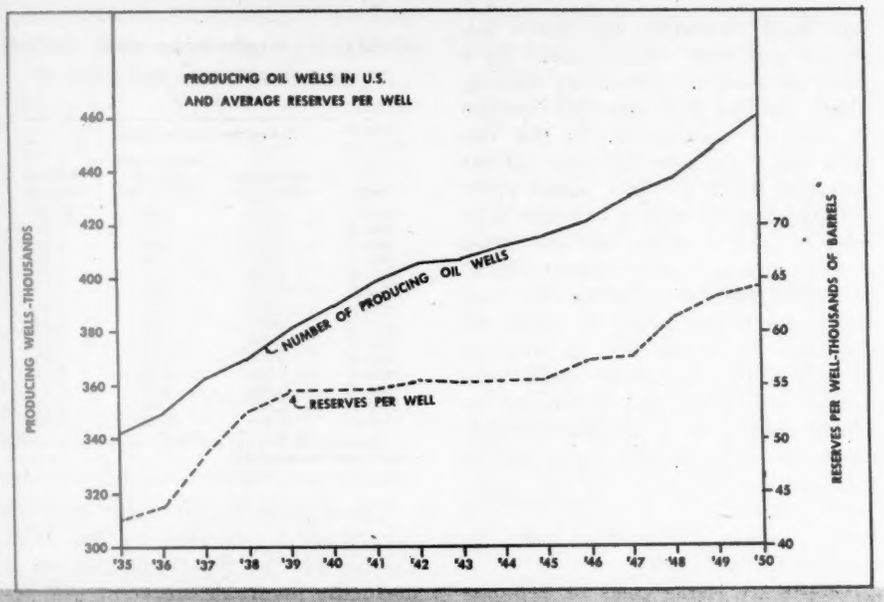


FIG. 7

standpoint of economy and national security. This favorable situation is due entirely to the relentless search for new reserves, which is dictated by the long-range oil supply program of the petroleum industry.

In the last five years, 1946-50, the average quantity of new oil reserves found per producing well in new fields amounted to about 761,000 bbl. In 1950, the rate was 636,000 bbl per successful wildcat well. Extension drilling in previously discovered areas was far more lucrative. During the five-year period the average quantity of oil found per producer completed was 8,616,000 bbl. In 1950, the rate was 7,180,000 bbl per producer. An index of discovery rates in relationship to exploratory activity is found by combining wildcat discovery wells and all dry holes drilled, exclusive of gas wells, which may be used as a divisor to determine the incidence of reserves discoveries per exploratory well. In the last five years, the average quantity of new reserves found, through new fields and extensions to older fields, amounted to 174,000 bbl per well drilled. Estimates for 1950 indicated a rate per well of only 147,000 bbl, as compared with an average in 1949 of 200,000 bbl per exploratory well. Composite results of wildcat operations in the last five years have shown an average discovery rate per producer completed of 2,316,000 bbl.

Preliminary studies indicate that well abandonments in 1950 aggregated 12,511, which were offset about two to one by new oil well completions totaling 24,031 producers. In the last five years, the oil industry in the United States has had to abandon a total of 56,866 wells which had reached their economic limits as producers. Offsetting these abandonments, and contributing to the consistent upward trend in the nation's productive wells, were new oil well completions aggregating 101,316 producers. Well abandonments during the last five years have averaged 11,373 annually, which indicates the imperative need for an uninterrupted drilling program. In 1950, the industry drilled a total of 42,804 wells, including input wells. This year, the drilling program calls for the completion of about 44,000 wells, which will be dependent largely upon the availability of oil field equipment.

The trend of reserves discovery rate per well drilled is downward. In the last six years, the quantity of reserves credited to wildcat drilling has declined 46 per cent. In 1945, discoveries per wildcat well averaged 626,000 bbl, while in 1950 the average was 338,000 bbl. Similar trends are revealed in discovery rates per well for all wells drilled and for all dry holes drilled. The average discovery credited to all wells drilled has declined since 1945 by 38 per cent, while the rate per dry hole drilled is off 46 per cent. This is the result obtained by crediting revisions in estimates to original discovery years. Obviously such oil cannot be credited to current exploration activities, since it represents under-estimates of previous discoveries. The accumulation of such credits, together with new discoveries made in the last 6 years reveals a

TABLE 7. Producing wells and reserves per well in the United States.

Year	Producing wells Dec. 31	Proved reserves* (Mill. bbl)	Reserves per well
1935	340,990	14,492	42,500
1936	349,450	15,160	43,380
1937	363,030	17,622	48,540
1938	369,640	19,507	52,770
1939	380,390	20,690	54,390
1940	389,010	21,281	54,700
1941	399,960	21,873	54,690
1942	404,840	22,383	55,290
1943	407,170	22,399	55,010
1944	412,220	22,710	55,090
1945	415,750	23,184	55,764
1946	421,460	24,027	57,008
1947	429,637	24,755	57,681
1948	437,880	26,854	61,327
1949	448,680	28,430	63,809
1950(p)	460,200	29,606	64,332

* Including natural gas liquids, partly estimated
(p) Preliminary

TABLE 8. Drilling and exploratory results.

	1946	1947	1948	1949	1950(p)	Total 5 years
Wildcats						
Oil wells (New fields)	498	660	783	880	980	3,801
Oil wells (Ext)	141	142	177	233	245	938
Gas wells	145	207	245	203	233	1,033
Dry holes	3,831	4,192	5,100	5,556	6,606	25,285
Total	4,615	5,201	6,305	6,872	8,064	31,057
Development dry holes	4,933	5,407	6,790	7,356	8,418	32,904
Total exploratory wells	9,548	10,608	13,095	14,228	16,482	63,961
Development oil wells	14,771	17,235	21,068	20,697	22,806	96,577
Development gas wells	3,093	3,183	2,584	2,776	2,684	14,320
Total	27,412	31,026	36,747	37,701	41,972	174,858
Input wells	2,242	2,264	2,159	1,184	832	8,681
Grand total	29,654	33,290	38,906	38,885	42,804	183,539
New fields						
Oil wells completed	498	660	783	880	980	3,801
Reserves discovered (million)	323	505	461	983	623	2,895
Average per well (thousand)	649	765	588	1,117	636	761
Extensions						
Oil wells completed	141	142	177	233	245	938
Reserves discovered (million)	1,312	1,387	1,809	1,815	1,759	8,082
Average per well (thousand)	9,305	9,768	10,229	7,790	7,180	8,616
Composite						
Oil wells completed	639	802	960	1,113	1,225	4,739
Reserves discovered (million)	1,635	1,892	2,270	2,798	2,382	10,977
Average per well (thousand)	2,558	2,359	2,364	2,514	1,944	2,316
Total exploratory wells						
Wells drilled*	9,403	10,401	12,850	14,025	16,249	62,928
Reserves discovered (million)	1,635	1,892	2,270	2,798	2,382	10,977
Average per well (thousand)	173	182	176	200	147	174

* Excludes wildcat gas wells. (p) Preliminary.

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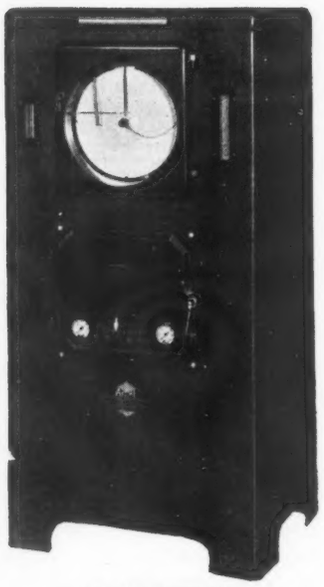

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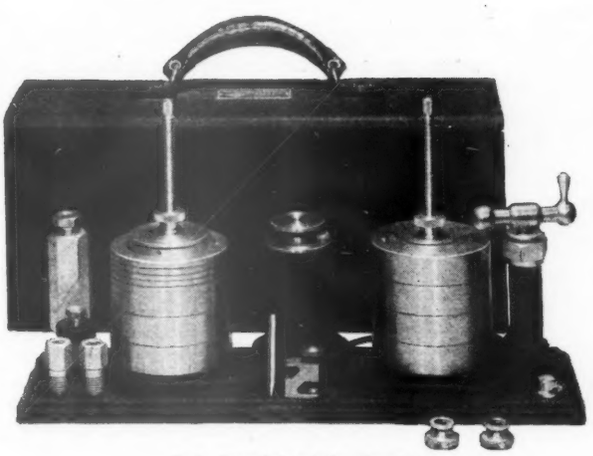

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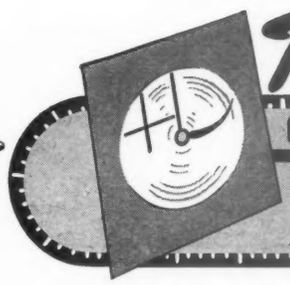

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marked decrease in discovery rate per well in comparison with averages in 1935-37. Average reserves credits to wildcat operations in the former period were 1,407,000 bbl, whereas the average in the last 6 years was 526,000 bbl.

That there is a definite need for a continued upward trend in drilling operations in the United States is revealed by the number of wells drilled per million barrels of oil found. In 1950, the oil industry drilled 6.8 exploratory wells for each million bbl of reserves found. In the pre-war period, 1935-37, only 3.5 wells were drilled per million bbl found. The facts show that it was necessary in 1950 to drill 6.3 dry holes to find a million bbl of reserves, whereas in 1935-37, only 3.4 dry holes were drilled for each million bbl of oil found. Since 1935-37, the number of discovery wells drilled per million barrels of reserves found has increased by 5 to 1. These facts emphasize the need for increasingly larger expenditures for exploration, and definitely support the oil industry's position with respect to the statutory depletion allowance.

Reserves discovery data of the last 16 years shows that 77 per cent of all the oil found by exploration has been credited to extensions of previously discovered fields, and revisions in previous estimates. Only 23 per cent of the oil was attributed to new field exploration. In 1950, about 81 per cent of the total was credited to extensions and revisions. Over a period of 16 years, the oil industry found 41,178,000,000 bbl of reserves, and produced 25,815,000,000 bbl. Despite the growing productive requirements for oil, the nation's reserves during the 16-year period were increased 15,363,000,000 bbl, which brought the proved reserves at the close of 1950 to a new high level of 29,606,000,000 bbl.

The allocation of oil discovered by extensions and revisions to original discovery years provides a yard-stick for measuring the ultimate size of the annual new field discoveries. Studies indicate that the ratio of ultimate reserves credits to original discoveries of new fields, over a period of 16 years, has averaged 4.1. In the last eight years, the median of these annual ratios was 5½ times original new field discoveries. Average annual discoveries in new fields, during this period, amounted to 431,000,000 bbl, while ultimate credits by extensions and revisions brought the annual discovery up to 2,242,000,000 bbl. This

TABLE 9. Reserves discoveries related to drilling activity.

		Wildcats drilled		All wells drilled		Dry holes drilled	
	New reserves discovered† (million bbl)	No. wells	Reserves discovered per well (thousand)	No. wells	Reserves discovered per well (thousand)	No. wells ‡	Reserves discovered per well (thousand)
Average 1935-37	2,744	1,949	1,407	25,994	105	5,542	493
1945	2,569	4,105	626	24,833	104	7,646	335
1946	2,457	4,615	532	27,412	90	8,764	280
1947	2,823	5,201	543	31,026	91	9,599	294
1948	2,663	6,305	422	36,747	72	11,890	224
1949	3,105	6,872	452	37,701	82	12,912	240
1950	2,730*	8,064	338	41,972	65	15,024	181
Total 6 years	18,495	35,162	526	199,691	93	65,835	281

† New fields and extensions, with revisions in previous estimates credited to original discovery years.
‡ Excludes input wells.
* Adjusted for probable upward revision in 1950 estimate.

TABLE 10. Wells drilled per million barrels of reserves found.

		Number of wells per million barrels found		
	New reserves found† (million bbl)	Discovery wells‡	Wildcat and development dry holes	Total exploratory wells
Average 1935-37	1,637	0.1	3.4	3.5
1945	1,581	0.3	4.8	5.1
1946	1,635	0.4	5.3	5.7
1947	1,892	0.4	5.1	5.5
1948	2,270	0.4	4.8	5.2
1949	2,798	0.4	4.6	5.0
1950	2,382	0.5	6.3	6.8
Total 6 years	12,558	0.4	5.2	5.6

† Reserves found in new fields and by extensions, exclusive of revisions in previous estimates.
‡ New fields and extensions.

FIG. 8

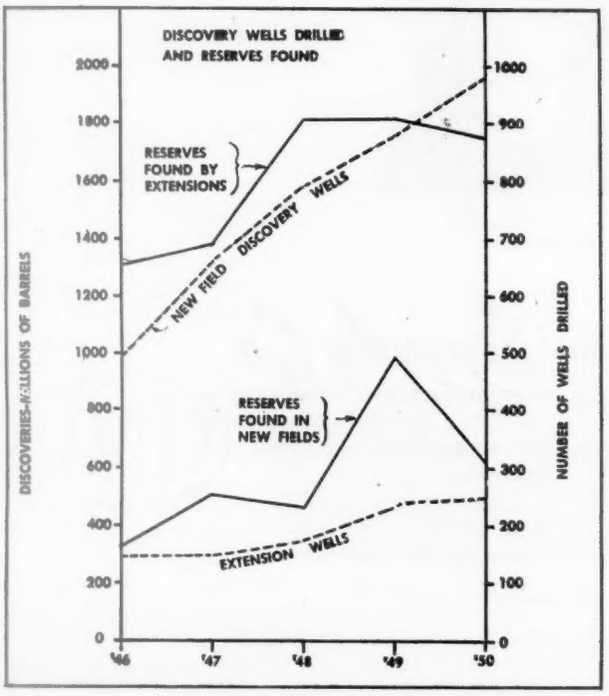


FIG. 9

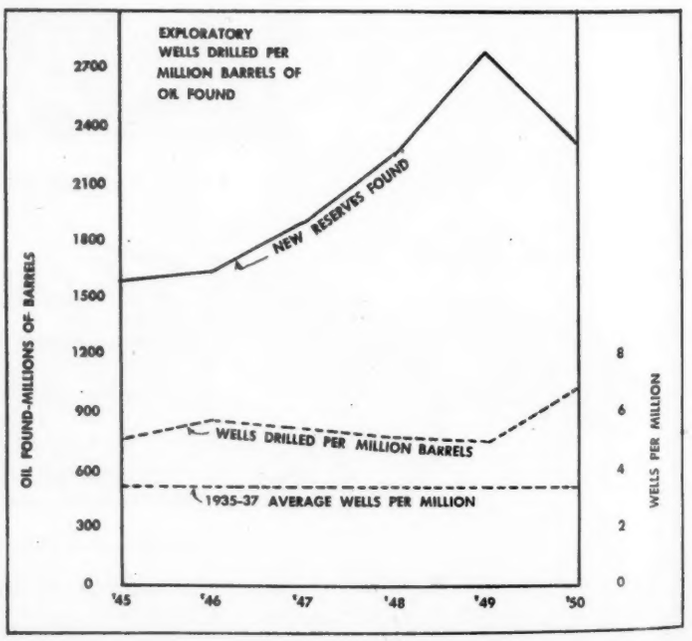


TABLE 11. Petroleum liquid reserves, discoveries, and production.

(Millions of barrels)

Year	Reserves beginning of year	New pools discoveries	Extensions and revisions	Total oil added	Production	Net increase	Allocation of extensions and revisions	Ultimate reserves credited to original discoveries	Adjusted reserves, end of year	Ratio, ultimate credits to original discoveries
1935	14,243	955	330	1,285	1,036	249	1,620	2,575	19,506	2.70
1936	14,492	860	950	1,810	1,142	668	1,988	2,848	21,212	3.31
1937	15,160	940	2,850	3,790	1,328	2,462	1,878	2,818	22,702	3.00
1938	17,622	825	2,325	3,150	1,265	1,885	2,373	3,198	24,535	3.88
1939	19,507	360	2,140	2,500	1,317	1,183	2,042	2,402	25,720	6.67
1940	20,690	315	1,685	2,000	1,409	591	2,162	2,477	26,788	7.86
1941	21,281	455	1,620	2,075	1,483	592	1,907	2,362	27,667	5.19
1942	21,873	280	1,700	1,980	1,470	510	2,017	2,297	28,494	8.20
1943	22,383	345	1,265	1,610	1,594	16	2,138	2,483	29,383	7.10
1944	22,399	515	1,574	2,089	1,778	311	2,149	2,664	30,269	5.10
1945	22,710	440	1,870	2,310	1,836	474	2,206	2,646	30,222	6.00
1946	23,184	323	2,370	2,693	1,850	843	1,921	2,244	30,616	6.90
1947	24,027	505	2,211	2,716	1,988	728	1,873	2,378	31,006	4.70
1948	24,755	461	3,805	4,266	2,167	2,099	1,124	1,585	30,424	3.40
1949	26,854	983	2,592	3,575	1,999	1,576	657	1,640	30,065	1.60
1950	28,430	623	2,706	3,329	2,153	1,176	—	1,694*	29,606	2.70
1951	29,606	—	—	—	—	—	—	—	—	—
Totals	—	9,185	31,993	41,178	25,815	15,363	28,055	38,311	—	4.10(a)

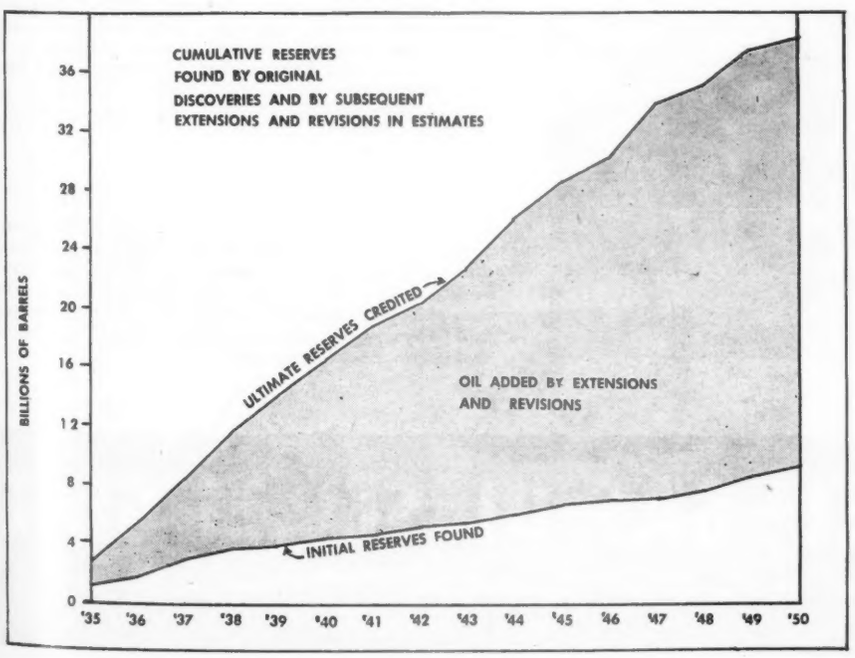
* To balance proved reserves as of Dec. 31, 1950*
(a) Median—8 years, 1942-49, is 5½ times original discoveries credited.
Source of original data: Joint Committee on Reserves of The American Petroleum Institute and the American Gas Association. Slight differences in figures are due to author's revisions.

established a ratio of 5.2 times original reserves discoveries.

By crediting original discoveries with reserves subsequently added by extensions and revisions, it is found that the nation's proved reserves apparently exceeded 31,000,000,000 bbl at the close of 1947. At any rate, back credits to original discoveries are believed to have added more than 6 billion bbl to the estimated inventory at the close of 1947. By the same token, proved reserves at the close of 1950 may be expected to show a substantial increase, due to ultimate credits for extensions and revisions. If ratios of recent years are realized in the future, it is not unlikely that ultimate credits through extensions and revisions will have increased today's proved reserves to a total of about 35,000,000,000 bbl. This will, of course, only be accomplished over a period of perhaps the next eight to ten years, and will involve exploration expenditures of several billions of dollars.

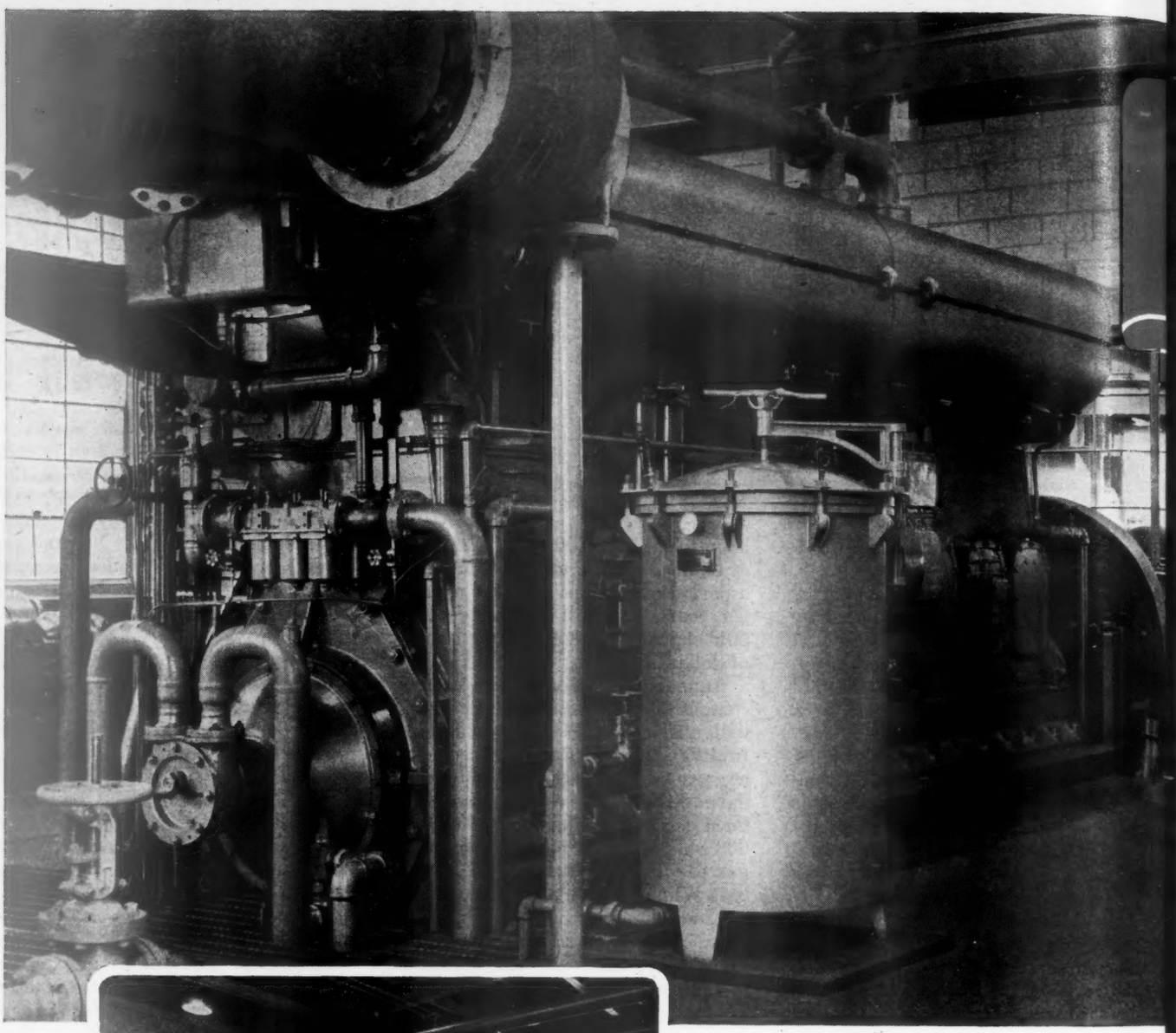
Annual production figures used in computing the petroleum reserves situation represent all petroleum liquids. In 1950, the production of crude oil aggregated 1,971,845,000 bbl, while the addition of the year's reported natural gasoline production of 181,155,000 bbl placed the total production of petroleum liquids at 2,153,000,000 bbl. While some natural gas liquids are recovered from oil wells, a major share of the production of natural gas liquids is obtained by the extraction of natural gasoline from natural gas. This is actually a refining, rather than a producing operation. Natural gas liquids produced as condensate from oil wells are usually mixed with crude oil and sold as such at the well. Estimates of proved reserves, compiled by the Joint Committee on Reserves of API and AGA, placed the 1950 year-end reserves of crude oil at 25,268,398,000 bbl, and also established the reserves of natural gas liquids at a total of 4,267,663,000 bbl. Total reserves estimated by the Committee were placed at 29,536,061,000 bbl, which differs slightly from the author's calculations, due to revisions in production figures and to some extrapolations to convert earlier estimates to a petroleum liquids basis.

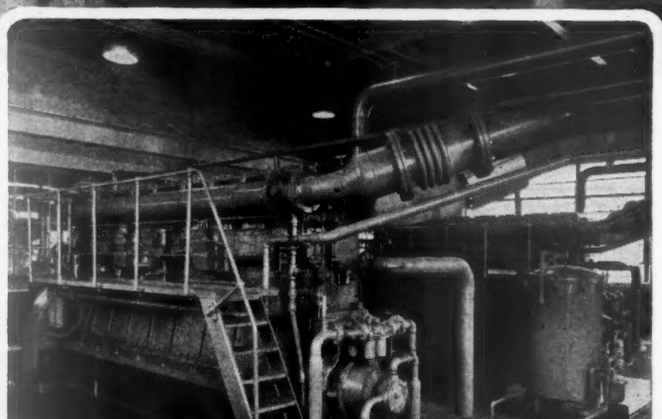
FIG. 10



Studies of exploratory activity and trends in reserves discoveries cannot fail to emphasize the need for the continued, unrelenting search for new sources of oil supply. The facts make it evident that oil is not as easy to find as it was in the earlier years, and that far greater effort, and vastly more capital is required to maintain the nation's petroleum reserves in conformity with expanding consumer requirements.

The necessity to drill 2½ times as many wells now as were found necessary in pre-war years, and the fact that the oil industry is now reinvesting one-third of the total working interest value of crude oil production in the search for new reserves, places a preponderant weight of evidence in favor of the oil industry's fight for the retention of the 27½ per cent depletion allowance. The future outlook demands a continued high rate of drilling and exploration for new reserves, which will necessarily involve increasingly larger expenditures of capital. The depletion provision has for many years served as the enabling factor in the maintenance of the nation's petroleum reserves. * * *





Cooper-Bessemer LS-8 supercharged gas-diesel, 1,715 hp, in Mid-Valley Clarkson station. Number of these units on line will soon total 15 . . . 3 in each of 5 different stations, including new stations at Pyrmont, Ohio, and Simpsonville, Kentucky and Minter City, Miss.

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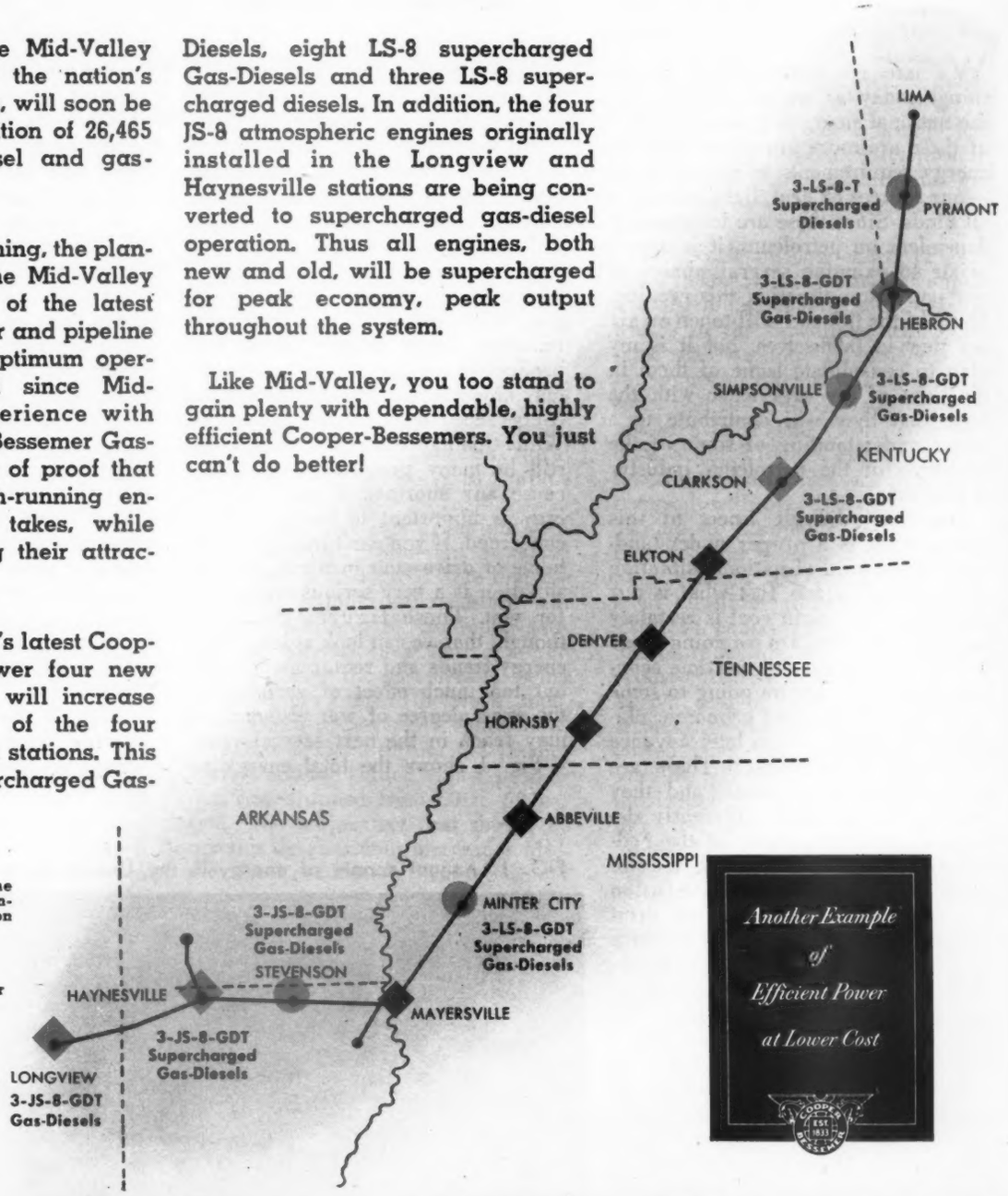

Map of Mid-Valley Pipe Line Company's 1000-mile system including new stations and station expansions.

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PETROLEUM and The National Emergency*

HOWARD G. VESPER†

WE are concerned about many things today as we get further into the national emergency situation. Few of these are more important than the energy requirements of our economy —our sources of heat, light, power of all kinds. Since these are increasingly dependent on petroleum, it is appropriate to examine several phases of our petroleum situation this evening. Many of the things I will touch on are not new in themselves, but it is my plan to consolidate some of them in the light of my experience with the hope that they will contribute to a better understanding of some of the problems of the petroleum industry at this time.

One very difficult aspect of this examination is a proper understanding of what kind of national situation we are heading for. Just what is our objective? Our main goal is certainly to avoid war. But, are we going to do this by going to a full wartime economy basis? Or, are we going to some indefinite intermediate economic plateau from which we can later advance or retreat as necessary? These are most important questions, and they seem to be answered differently depending on what section of the Federal Government is involved. We are going through the period of confusion that seems characteristic of our democratic way and will doubtless arrive in good time at an agreement. Meanwhile, if I am somewhat general in discussing certain points, I hope you will understand this is inherent in the present situation.

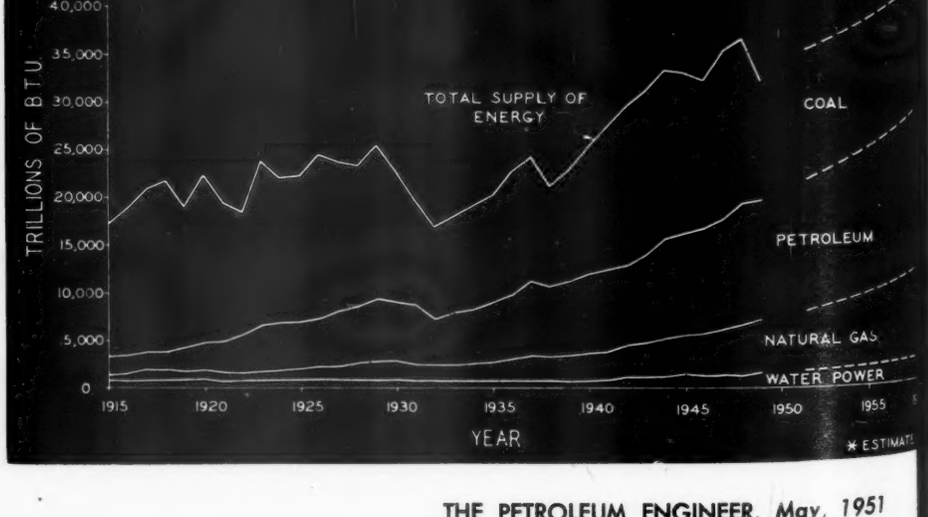
Our way of life—either in peace or in war—involves a prodigious use of energy. Last year every man, woman and child in these United States required an average of 250 million Btu of energy in one form or another. Expressed in better known terms, *this amount of energy is equivalent to enough gasoline for each person in the country to drive a car completely around the world during the year!*

An interesting thing about our energy need is that it does not increase very much in a war period over the normal historical rate of increase. This is because we have a very productive economy that is running in high gear already and because we divert from civilian to war needs with relatively minor changes in our total productive capacity. A full war economy now would probably increase our energy need only around 5 per cent. While this figure is small, there would still be many problems involved because any shortage in available energy is important to the individuals concerned. If you can't heat your own home or drive your own car, then the situation is a very serious one indeed for you. These figures do mean, though, that we can look at long range energy trends and requirements without too much effect of variation in the exact degree of war economy we may reach in the next several years.

Fig. 1 shows the total energy requirement of the United States for several decades, with a guess as to 1960 needs. Since 1915 the use of oil and gas has increased over 700 per cent and has supplied almost all of the added energy we have needed for our expanding economy. Except for the depression years, when it declined, coal production has been substantially constant. Our total energy figures have been increasing for many years and are now more than double the values for 1915. This increase roughly paralleled the growth in population up to World War II, so that per capita energy rates stayed about the same during the 20's and 30's. Since the war this unit rate has jumped about 20 per cent to furnish striking evidence of a real increase in our standard of living through greater use of machines for the production of food, goods, and services. All signs point to a continued energy expansion and this is the basis for the projection to 1960.

Fig. 2 shows where this energy comes from. Most striking is the steady decline in the proportion ob-

FIG. 1. Annual supply of energy in the United States.



*Presented as a public lecture under the sponsorship of the Department of Engineering, University of California, at Berkeley, February 26, 1951, and at Los Angeles February 28, 1951.

†California Research Corporation, San Francisco, California.

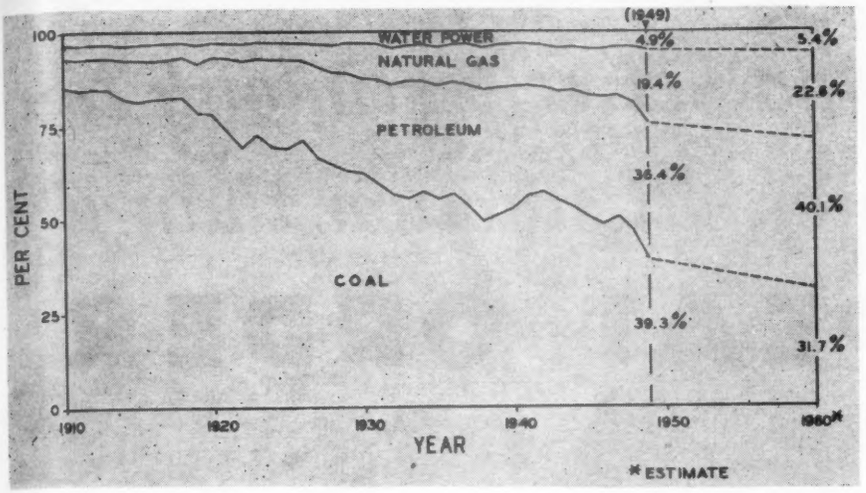


FIG. 2. U.S. consumption of energy by energy source.
(As per cent of total supply.)

tained from coal and the expectation that it will continue to drop. With hydro power contributing a substantially constant percentage of total energy, this conversion from coal has been to both petroleum and natural gas. Reasons are many, some of the more important being the greater efficiency and convenience in using oil products and gas, easier transportation of these materials, labor problems within the coal industry. Especially significant is the accelerated rate of natural gas use during the last several years. It is expected that the share of total energy from both petroleum and gas will continue to increase during the current decade. Their combined total is now about 56 per cent and this should go up to well over 60 per cent by 1960.

The same general energy relationships hold for the West (Fig. 3), but petroleum and gas became dominating factors much earlier and for 20 years have accounted for 80 per cent or more of the total energy in the 5 western states. The proportion from petroleum has changed very little since the early 20's, but gas energy has increased steadily in relative importance. No particular change in these general relationships is expected during the next few years.

With petroleum being the largest factor in supplying both our national and regional energy needs, it is appropriate to look at available supplies. Since petroleum moves freely in international trade in normal times —and even under some war conditions — this question must be approached from the world as well as from the national and regional standpoints. Fig. 4 shows world production trends over the last decade and illustrates a tremendous expansion, especially postwar. World production exceeded 10,000,000 bbl daily in 1950 for the first time, nearly double 1939. About three-fourths of this came from the western hemisphere, but eastern hemisphere production is increasing rapidly. It is very fortunate—and one of today's prime political and military considerations—that most of the world's oil is in "friendly" hands. Production available today to Russia and her satellites is comparatively small. far below what the western world would consider necessary to support a major war effort.

These relationships in the distribution of world oil production are shown more clearly on Fig. 5. Note that the total production of the eastern and western hemispheres combined (excluding Russia) has not changed greatly during the past decade, being about 90 per cent of the world total. The eastern hemisphere's share, however, has doubled during the 10-year period, and the United States' proportion has dropped from 60 to 52 per cent. The major fact that should be noted is the enormous increase in Middle East production, from 6 to 17 per cent of the world total. This reflects principally large production increases in Saudi Arabia and Iran. In spite of this, the fact remains that the United States is still producing as much petroleum as the rest of the world combined!

It is interesting to reflect for a moment on what would happen to this balance of world crude oil production if Russia were to move in such a way as to add part or all of the Middle East to its area of domination. Iran's oil alone would nearly double the Soviet's available production and the further addition of Iraq, Arabia, and the other near-by areas would swell the figure to over 2,500,000 bbl daily! This is about one-fourth of the world total, and even though it is only half as large as the United States production, it is a figure that might well prove adequate for the Russian war machine.

Two world oil flow charts (Figs. 6 and 7) show how the world oil supply was distributed in 1938 and 1950. The widths of the flow lines are on the same scale on both. In 1938, the major supply to Europe was from Venezuela and the United States, amounting to over 500,000 bbl daily, with only about 175,000 bbl daily from the Middle East. This is now sharply reversed, with over 800,000 bbl daily moving to Europe from the Middle East and the Venezuela supply dropping to about 200,000. This development of Middle Eastern oil has the effect of conserving western hemisphere production, and it is reassuring to know that by 1952 it appears only 11 per cent of western Europe's increasing requirements will be imported from this hemisphere. There are now practically no exports from the United States to the Orient, and there is an appreciable amount of Middle East oil coming to the United States to supplement our supply.

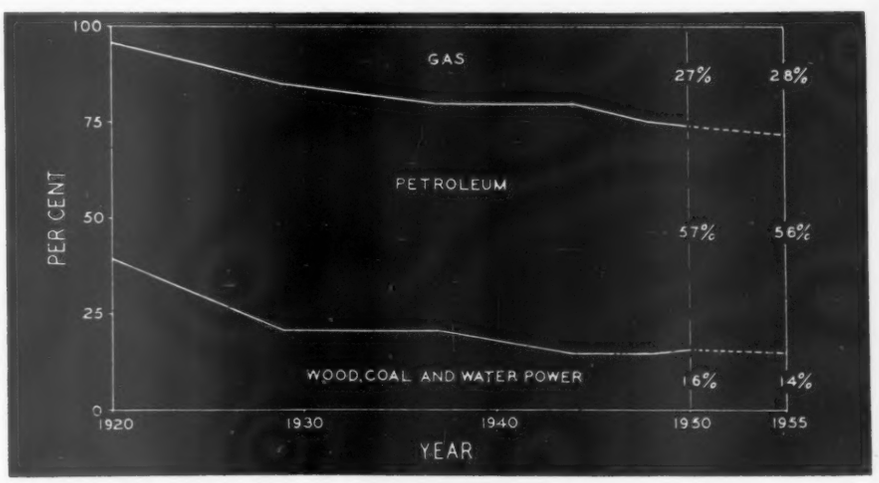


FIG. 3. Consumption of energy in the five western states by energy sources.
(As per cent of total supply.)

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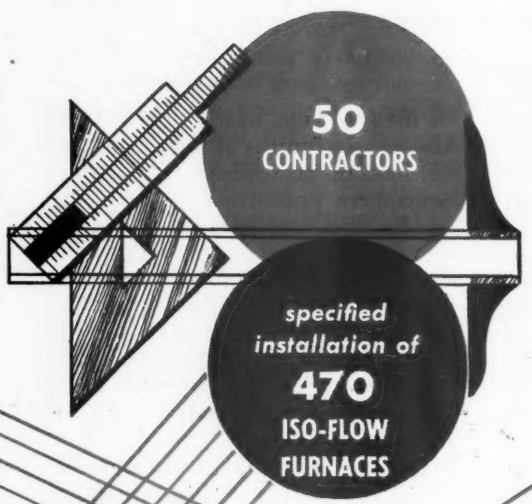

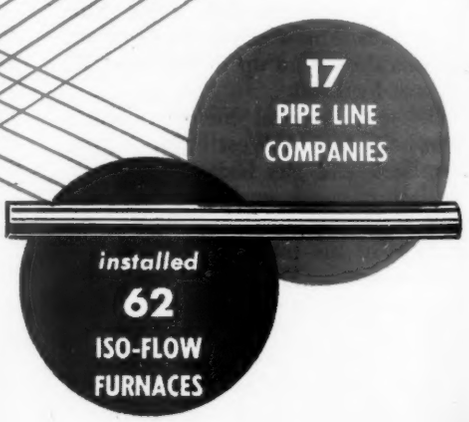

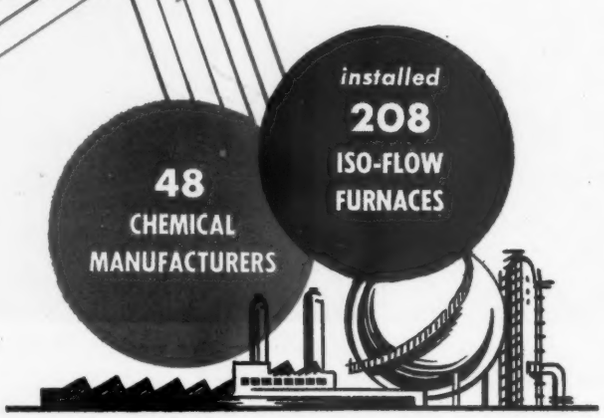

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37
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REFINING COMPANIES

installed
385
ISO-FLOW FURNACES

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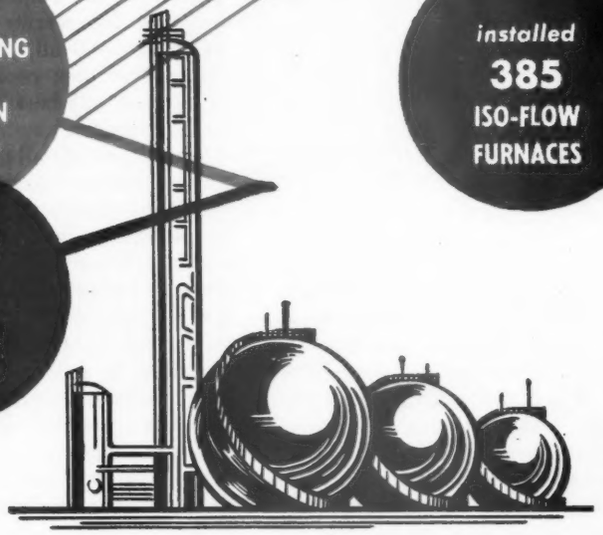
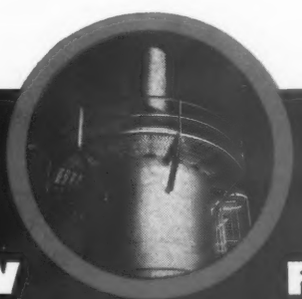


The Petro-Chem Iso-Flow Furnace repeat order record is a magnificent tribute to their design, construction and efficient performance.



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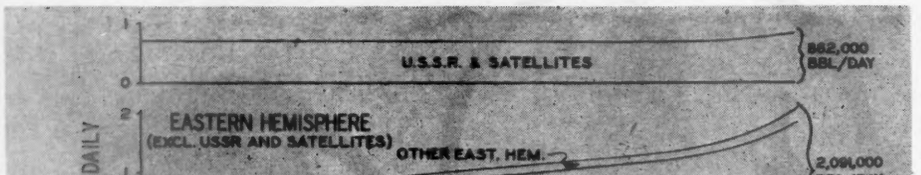


FIG. 4. Crude oil production.

Larger quantities of Venezuela oil are also moving to our shores.

For better perspective, these figures should be viewed with reference to reserves. These are generally considered to be of two kinds—"proved" and "probable". The former is a conservative figure built up from known data on individual fields; the latter is an "educated guess" as to a more likely figure, giving weight to the possibility of finding new fields. Fig. 8 shows that most of the world's production so far has come from the United States; in fact, far more than from all the rest of the world together (41 billion barrels versus 25). Proved reserves, however, are quite another story, with the United States smaller than the Middle East, and the totals for the western and eastern hemispheres about equal. The combined proved reserves of the "friendly" world are over 70 billion barrels, compared with about 5 billion for Russia and her satellites. These reserves are equivalent to about 20 years at the 1950 rate of world production.

Estimated ultimate production figures again show the western and eastern hemispheres about the same, with figures of a magnitude to give promise of adequate petroleum supplies for a very long time ahead—over 100 years at the 1950 rate. Attention is directed to the very much higher potential for the Russian group; geological prospects are considered quite promising for certain Russian areas.

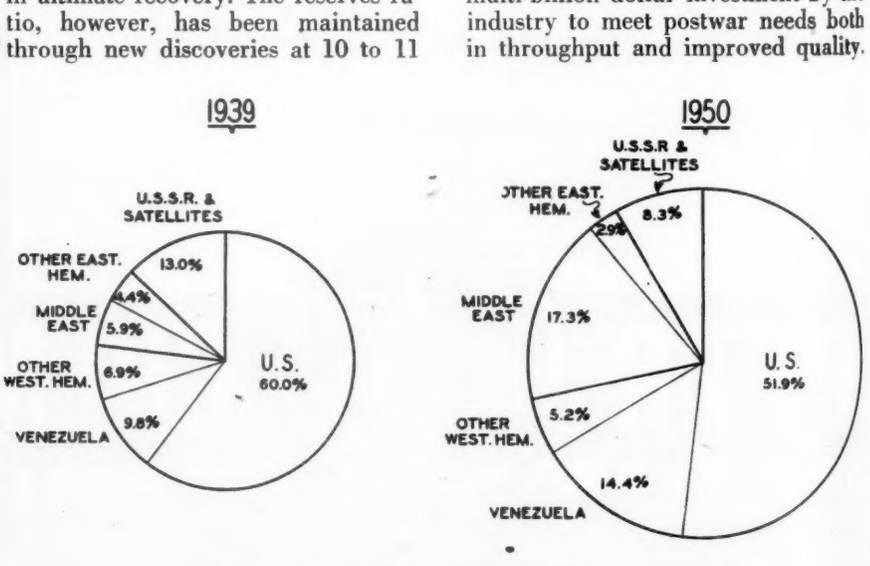
The next figure (9) shows the United States situation. We are now producing over 2 billion barrels yearly; but in spite of an increase of nearly 5 times in our production rate over a 30-year period and nearly doubling our figures in the last decade, our ratio of proved reserves to current year's production has remained about the same—around 13 to 14 years. The actual ratio in 1940 was 14.1 years, and 1950 was 13.8.

Corresponding figures for the 5 western states are somewhat less favorable but still impressive (Fig. 10). Production has trebled in the last 30 years, but the reserves ratio now is only about one-half what it was then. In spite of active efforts to improve it, the production curve has remained practically straight since the latter part of the war at about the maximum rate of which the California fields are capable without undue reduction in ultimate recovery. The reserves ratio, however, has been maintained through new discoveries at 10 to 11 years during this same period; the 1950 figure is 11.7 years.

This continuing record of reserves ratios of 10 years or more for California and for the nation is a remarkable tribute to the industry's oil-finding ability, but it does not mean a guaranteed supply of oil for that period of time. This is because the rate at which fields produce declines as they become older, so that a very much longer time would be needed actually to obtain the amounts of crude considered as "proved" reserves. This highlights the importance of continued new discoveries and of augmenting our own supplies from other areas. Our past record in doing this is perhaps our best indication of continued success.

Now, what do all these facts and figures on national and world oil add up to? They simply mean there is plenty of petroleum in the world for all of our needs now and for a very long time to come—war economy or not. *But* — and this is a very important qualification—this is true only so long as there is ready access to foreign oil, a condition dependent in large measure upon the degree of war we may encounter.

Our average crude production in the United States currently is about 5,800,000 bbl daily (including natural gas liquids). Refinery runs are approximately 6,400,000 bbl, including about 600,000 bbl of foreign crude. This is an all time record for refinery throughput and is about one-third higher than the rate at the end of the war. This amazing capacity increase in 5 years is the result of a multi-billion dollar investment by the industry to meet postwar needs both in throughput and improved quality.



76.7%	TOTAL WESTERN HEMISPHERE	71.5%
10.3%	TOTAL EASTERN HEMISPHERE (EXCLUDING U.S.S.R. AND SATELLITES)	20.2%
87.0%	TOTAL	91.7%

FIG. 5. World distribution of crude oil production.

The current crude production rate is about the same as in 1950 and can probably be increased further from present sources. But if the full difference between our own production and demand were made up from within the United States, the crude withdrawal in some areas might be so rapid as to reduce ultimate recovery appreciably. We have been both importing and exporting petroleum for many years, but the quantities were somewhere nearly in balance until about the end of the war. The difference has increased steadily since then to the current net import figure of more than half a million barrels daily. It is therefore important under present emergency conditions to consider building up further at an early date our own capacity to produce and refine. The industry is quite aware of this need and is currently undertaking a study of what would be necessary in terms of capital and materials to increase our national production of petroleum products by one million barrels daily. This study is being sponsored by the National Petroleum Council, representing a cross-section of the petroleum industry and serving as an advisory group to the Secretary of the Interior.

The current West Coast supply situation is complicated somewhat by the Korean episode and stepped-up military activity in the Pacific area. The California fields have been producing at about an even rate of somewhat in excess of 900,000 bbl daily for several years. The military requirement from the West Coast during this time was around 80,000 bbl. This increased to slightly over 100,000 bbl during the last half of 1950 and is expected to double in 1951! If sufficient wells can be drilled, it is hoped this requirement can be met; but both producing and refining facilities will be strained. During the last war, about 20 per cent of total petroleum products went to the military on a national basis, but—because of its proximity to the Pacific theater — California supplied about 30 per cent. Thus, history is repeating itself, and geography is requiring the West Coast oil industry to assume again a very disproportionate share of the military supply needs. Incidentally, these military figures will be higher in any future war because of our greater mechanization and our greater military use of prime movers, such as gas turbines, under conditions that sacrifice economy to performance.

Under these national emergency conditions, it is proper to give increasing consideration to alternate sources of liquid hydrocarbons within the United States; and the National

FIG. 6.

MAJOR OIL MOVEMENTS IN 1938

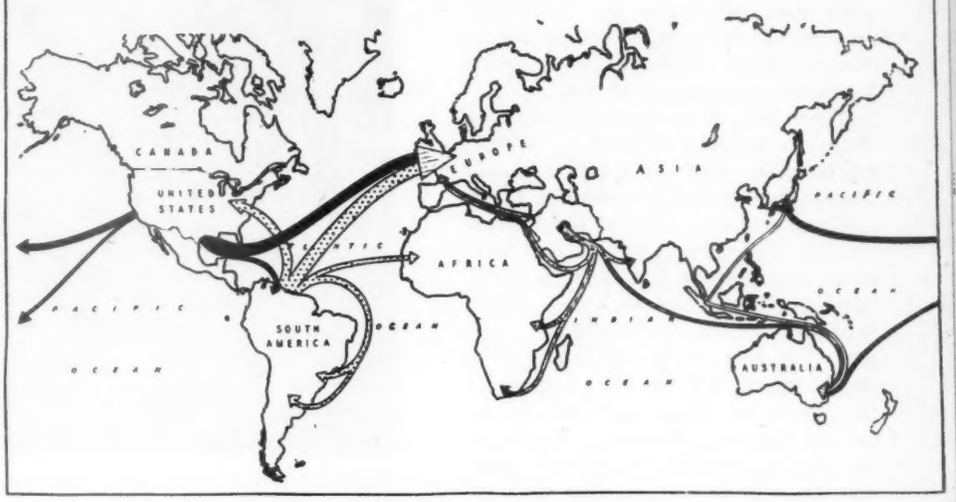
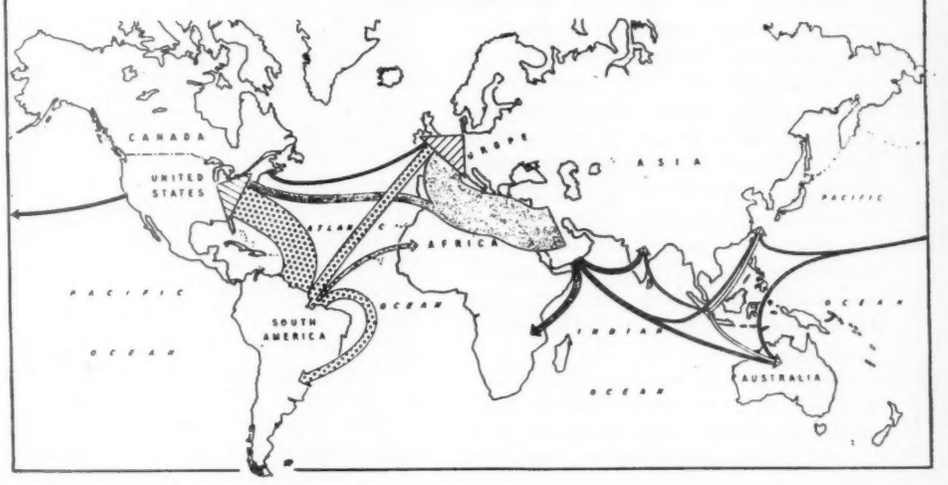


FIG. 7.

MAJOR OIL MOVEMENTS IN 1950
(ESTIMATED)



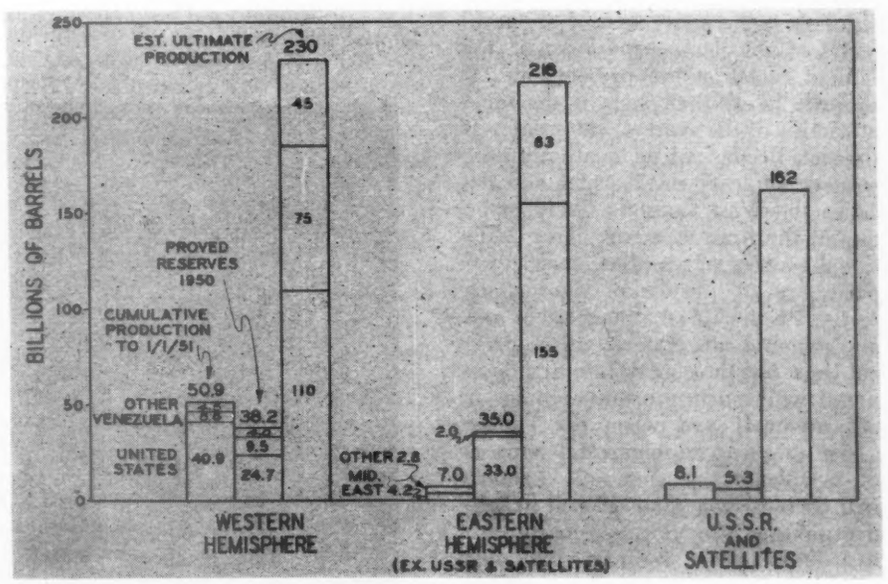


FIG. 8. World crude production and reserves.
(Excluding natural gas liquids.)

Petroleum Council is doing this also, working in close cooperation with the U. S. Bureau of Mines. There are three principal alternate or "synthetic" sources or processes deserving serious consideration: Shale oil, coal hydrogenation, and gas synthesis.

There are extensive deposits of oil shale in western Colorado, which, when heated, give off a liquid closely resembling crude petroleum. Yields averaging around 30 gal per ton are readily obtainable and sufficient technical information has been accumulated to permit refining this liquid into acceptable hydrocarbon products. The Bureau of Mines has done an excellent job in developing information on shale, particularly on the mining step. Retorting can be accomplished readily by several methods. Refining is more complicated and expensive than with crude oil, involving hydrogenation and, possibly, coking—unless the shale oil is integrated with the refining of larger quantities of crude petroleum.

Similarly, the technical problems with regard to both coal hydrogenation and gas synthesis are also quite well resolved, and both processes are feasible. The former simply involves the catalytic addition of hydrogen at high pressure and high temperature to coal for the direct production of liquid hydrocarbons. Gas synthesis comprises the production from coal or natural gas of carbon monoxide and hydrogen, which are then combined catalytically to form liquid products.

Enormous potential reserves are available through each of these three synthetic routes. For example, it is reliably estimated that at least 100 billion barrels of shale oil could be recovered from the Colorado deposits. This is the equivalent of about 50 years of petroleum production in the United States at the present rate. It is quite likely that shale is the most attractive of the synthetic alternates at present. Because of its location on the western slope of the Rockies and because the West Coast is likely to be one of the first areas requiring additional sources of supplies, shale prospects are of particular significance to the Pacific Coast. Shale oil is not an economic raw material at the present time, but the cost differential compared with existing crude supplies is not great. If and when the Pacific Coast requires supplemental sources of petroleum, an economic balance will decide when shale oil will fit into the picture. For normal conditions, it would be my estimate that this would not come about for perhaps another 10 years; but it is entirely possible that the military considerations involved in increasing our liquid energy supplies within the United States will accelerate the shale development into an active plant during the next several years.

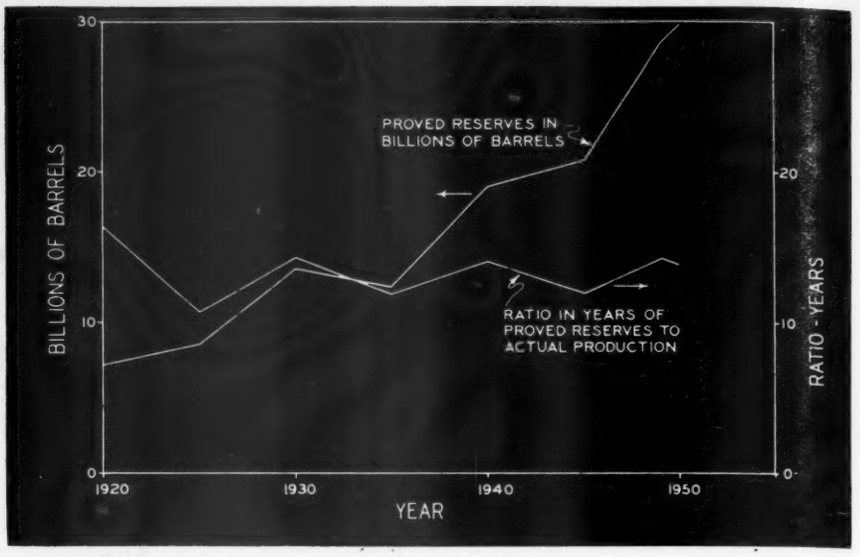


FIG. 9. United States crude production and reserves.
(Excluding natural gas liquids.)

The refiner will probably be very much "in the middle" during the emergency period. As we have seen, there should be enough raw material available—unless our ability to import foreign crude is curtailed by war or other limit on transportation. Nevertheless, there will doubtless be local areas of tight crude supplies from time to time, particularly as to preferred types for special uses. The major refining problems will center around large changes in demand for certain types of products, especially for military use and for industries working on military requirements. In other words, refinery flexibility—always desirable—will become more essential than ever.

One of the big problems will doubtless be that of providing enough "octanes" for antiknock quality of fuels for internal combustion engines, both aviation and automotive. While much of the new air equipment of the Armed Services is turbine powered, large dependence is still placed on planes using piston-type engines. It is quite probable that for the next several years at least, the requirement for aviation gasolines of the general type used in the last war will be at a high level. Experience in Korea has already indicated the significance of this need in terms of Pacific Coast refining. Even though increasing quantities of jet fuel may also be needed, fewer refining complications will be involved in its manufacture because of less rigid quality requirements.

The antiknock problem is already highlighted by recent publicity re-

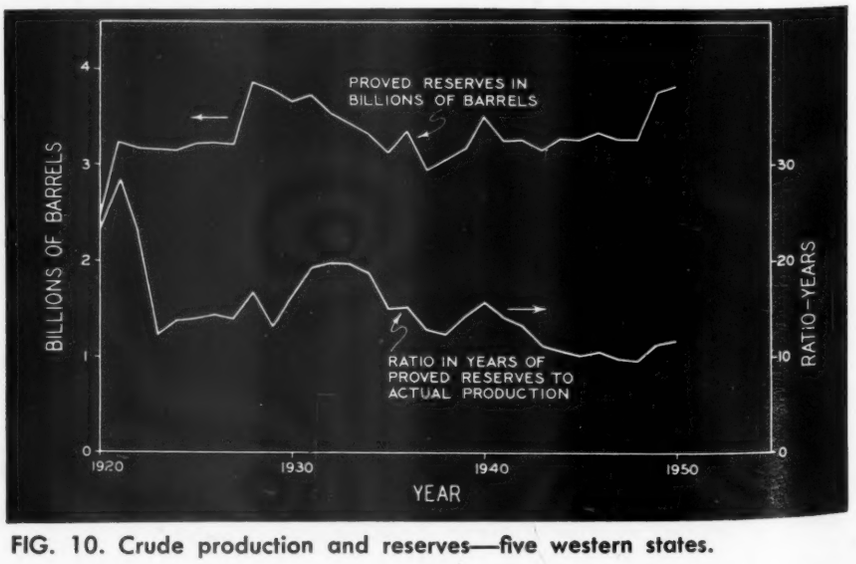


FIG. 10. Crude production and reserves—five western states.

garding the desirability of arranging for a stock pile of tetraethyl lead, which remains one of the basic means of obtaining needed "octanes". Considerable discussion is under way in Washington as to the best method of accomplishing this, the debate involving the alternate approaches of a Government limitation on the octane number of civilian motor gasolines or some percentage limitation by Government on the amount of tetraethyl lead available to refiners, who would then have complete freedom to use their supplies as they wish. Regardless of which method is used, the net result will probably be some drop in the octane number of civilian gasolines.

Along with this potential curtailment in tetraethyl lead availability, the refiner will of course make maximum use of other existing processes for octane upgrading, including thermal cracking and reforming, catalytic cracking in its various forms, and catalytic hydroforming. More catalytic cracking units of various types will probably be needed, along with their feed preparation systems. If the aviation gasoline demand continues to increase, it is quite likely that alkylation plants of the type used in the last war will be reactivated or new ones built. This method, whereby a paraffin hydrocarbon (generally isobutane) adds to an olefin to produce a branch chain structure, is an important method of octane upgrading.

There will be an extension of the catalytic hydroforming technique, first used during the last war, for the more efficient upgrading of low octane naphthas. This applied preferentially to certain naphthas high in naphthene content and resulted in the production of a considerable quantity of aromatic hydrocarbons, particularly toluene. The process is currently being expanded in its application by the use of new catalysts and different operating techniques so as to apply to a much wider variety of low octane naphthas.

One of the significant by-products of this work is the production of benzene from petroleum. If the feed stock to a unit of this newer type is limited largely to such materials as cyclohexane and methyl cyclopentane, operation under proper conditions of pressure, temperature, and catalyst permits almost quantitative conversion to benzene. While crudes containing large percentages of these naphthenes are not found widely, they are available in sufficient quantity to make this a potentially important addition to the country's benzene supplies.

One commercial plant of this type has already been announced, and others are under consideration.

The significance of this development is very great. Historically, benzene has been produced mainly from the coking of coal, and adequate quantities have been available. Recently, interruptions in the coal supply and greatly increased chemical use of benzene for many purposes have combined to make the benzene picture very tight. As a result, considerable quantities have been imported into the country during the last year at high prices. As we get further into the emergency period, requirements for this chemical will continue to increase. As an example, restrictions on the use of metals for many nonmilitary purposes will be met by conversion to plastics, thus increasing the need for benzene through such routes as polystyrene (which is made originally from benzene). The need for large quantities of benzene from petroleum will be important to our national picture and will have real significance in our economy.

The emergency situation will have other effects on the petroleum refiner from the chemicals standpoint. The phenomenal growth of the petrochemical industry in the last few years has made petroleum raw materials a major chemical factor. Increased production of such basic chemicals as ethylene, ammonia and others will be important considerations. Shortages of such chemicals as phenol and sulfuric acid, now used by the refiner in purifying petroleum fractions, will also create problems—leading to the use of alternate treating procedures or, possibly, changes in product quality.

All that I have said so far is general in its application, but we come now to a matter that is of direct importance to each individual—what may happen to petroleum product availability and quality. The first question, naturally, is about motor gasoline—will there be enough for all of us and how good will it be? The answers to both questions gear directly into how much war we have in our economy. As previously mentioned, our experience during World War II showed around 20 per cent of total petroleum products were needed by the military. Of this, about half was aviation and motor gasolines. Both figures would be higher for a major war today (including jet fuel). Since the national average gasoline yield from crude petroleum is slightly over 40 per cent, it is quite clear that over one-fourth of the total supply of gasolines would be diverted to the military from normal channels under full war conditions.

If we continue with a war preparedness economy somewhat as now developing and if foreign crudes continue to be available to this country, then there seems to me to be little likelihood of gasoline rationing. On the other hand, should we be forced to engage in a major war, then rationing seems inevitable. It should also be borne in mind that any decision on rationing may well be influenced by matters other than supply; for example, an important factor in gasoline rationing in the last war was a conservation of rubber by reducing passenger automobile tire miles. However, we are in much better shape on rubber now—thanks to the excellent synthetic rubber facilities constructed during the last war and now again in operation, in most cases by units of the petroleum industry.

Gasoline quality questions also depend largely on the degree of war. The current plan of stockpiling of tetraethyl lead will probably cause some reduction in the octane number of civilian motor gasolines, at least in some areas, but this should not be too serious for most cars. Some late models may have to tolerate slight knocking under some driving conditions or may require slight adjustments in spark timing to compensate.

Under war conditions, however, both volatility and octane would be adversely affected—as was the case in the last war. The result would be somewhat poorer starting and warm-up and a noticeably greater tendency to knock. The vapor pressure of gasolines would probably be increased to make up volume deficiencies, with resultant possibilities for more vapor locking troubles. The proportion of available first brand gasolines to second brand would doubtless decrease. But in spite of these changes, I am confident that a perfectly usable gasoline would be available, although in inadequate quantity to meet all present requirements.

Another petroleum product of major interest to the public is lubricating oil. Historically, the total requirement for lubricants is divided more or less equally between automotive and industrial uses. At the start of the last war, there was a sharp increase in the industrial demand, which continued at a high rate throughout the war period. This increase was more than enough to balance the drop in automotive lubricants due to fewer cars on the road and fewer car-miles driven. The net result was an increase of about one-third in total lubricating oil used. At the end of the war, the automotive demand shot to a new high, causing the postwar total to in-

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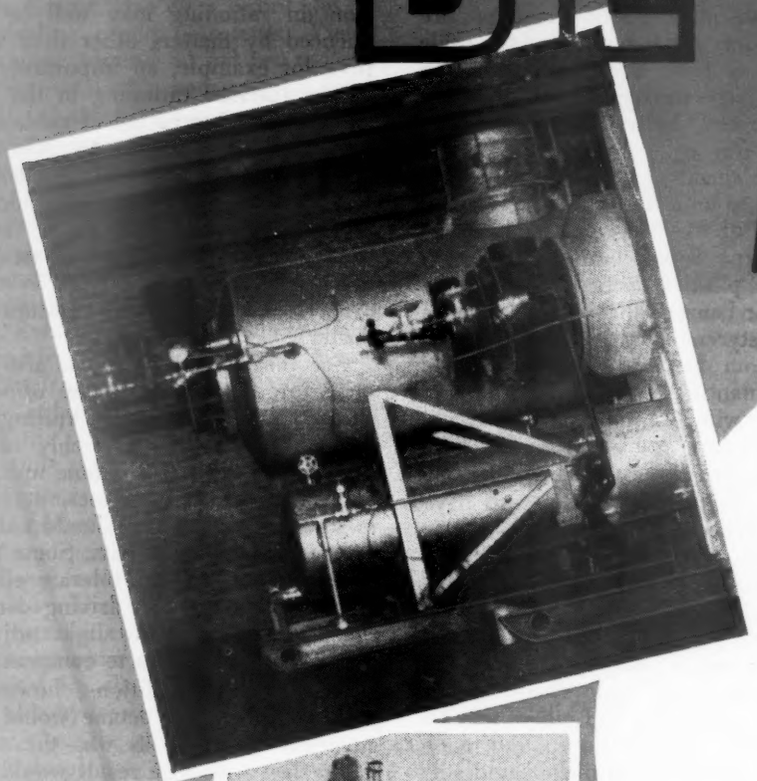

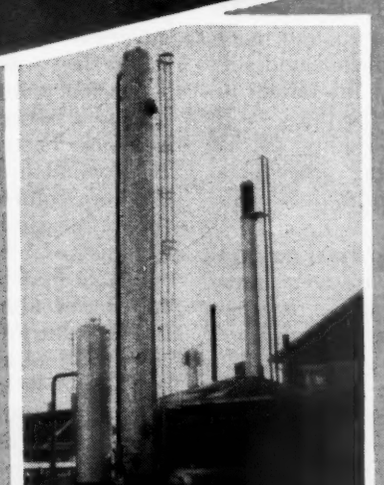

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crease well above the war time peak. This has been accompanied by a sharp increase in lubricating oil production capacity, amounting to about 25 per cent in the last two years alone. As a result, when the previous pattern begins to repeat and industrial lubricants begin to increase as the war material volume goes up, it seems likely that we will have an adequate lubricating oil supply.

However, the quality level may be affected. Lubricating oil quality has increased steadily during the last few years, principally through the use of more and better chemical compounding agents to improve such qualities as detergency, antiwear, anticorrosion, and stability. Much of our newer automotive equipment requires heavy duty and specially compounded lubricants for best maintenance and operation. A large increase in the use of such products by the Armed Services will probably cause shortages in such additives for civilian use, so that the lubricating oils available for their automobiles and similar equipment may be reduced in content of compounding. This should not be cause for alarm—the oils will still be of excellent quality, fully comparable to those available during the last war.

Other widely used petroleum products include diesel fuels and heating oils. Requirements for these fractions have skyrocketed during the last decade. Demand has more than doubled since prewar on the Pacific Coast, with most of the increase since 1945 —and the trend is still sharply upward. This is due to many factors, including particularly the great increase in oil heating for homes and the continued expansion of diesel power for railroads and for automotive use.

As with the other products mentioned, little change is expected in either quantity or quality unless real war conditions come. Then there would probably be rather sharp volume limitations, accompanied by definite quality restrictions. The latter would come about principally through the necessary use by the refiner of a wider variety of kinds of stocks in these products. Diesel fuel performance characteristics would not be affected to any severe degree but some problems of filter plugging and injector sticking might be encountered due to use of less stable petroleum fractions. Furnace oils might burn less cleanly and stove oils might deposit increased carbon in pot-type burners.

I was in a position during the last war to have a first hand part in many of the questions relating to both military and civilian product quality and availability. As a result, I am intimately familiar with the tremendous effort made by the petroleum industry to meet both the high military needs and at the same time to do the very best possible job for nonmilitary users. Because of this background, I was shocked to hear public criticism to the effect that the oil industry was taking advantage of the war situation to "dump" any kind of product on civilians because they would have to buy it anyhow. I can assure you that was not true, nor do I think it will have any validity in the present emergency. The petroleum industry, like any successful, competitive American industry, will succeed only to the extent that it serves its customers well and you may be assured that it will do its level best at all times to give its users the best products it can make for them under the circumstances of operation. The magnificant performance of the industry in the last war is the best insurance as we look ahead to the uncertainties and problems of the next few years.

In my 29 years in the oil business, I have come to have an unbounded admiration for the way in which the petroleum industry meets and solves its problems and keeps its responsibilities to both the Government and the public. It is a virile, dynamic, enthusiastic industry — willing to hazard large sums to meet needs both present and future. It seems to me vitally important to our economy that no steps be taken to hamper the industry in its ability to meet the challenge of the present national emergency.

In times like these, the Government looks to big business concerns because they are the products of successful American enterprise. They have learned to bring together supply and manufacture and transportation and research into one smoothly-working, integrated organization. They have the experience to do a big job, and do it well, in the shortest possible time. And they are willing and eager to "do a job".

And so I am gravely concerned when the Government with one hand asks such companies to undertake special tasks and increased military production, while with the other it sets up impediments that make it most difficult for these same companies to carry such jobs forward effectively. While money and effort have been poured into building up our national strength on one hand, some elements in Washington are trying to break up many of our larger companies and industries that make up the bulk of our productive capacity. One of the most dangerous tools in their hands has been the anti-trust suits, used to support the philosophy that bigness is in itself innately bad.

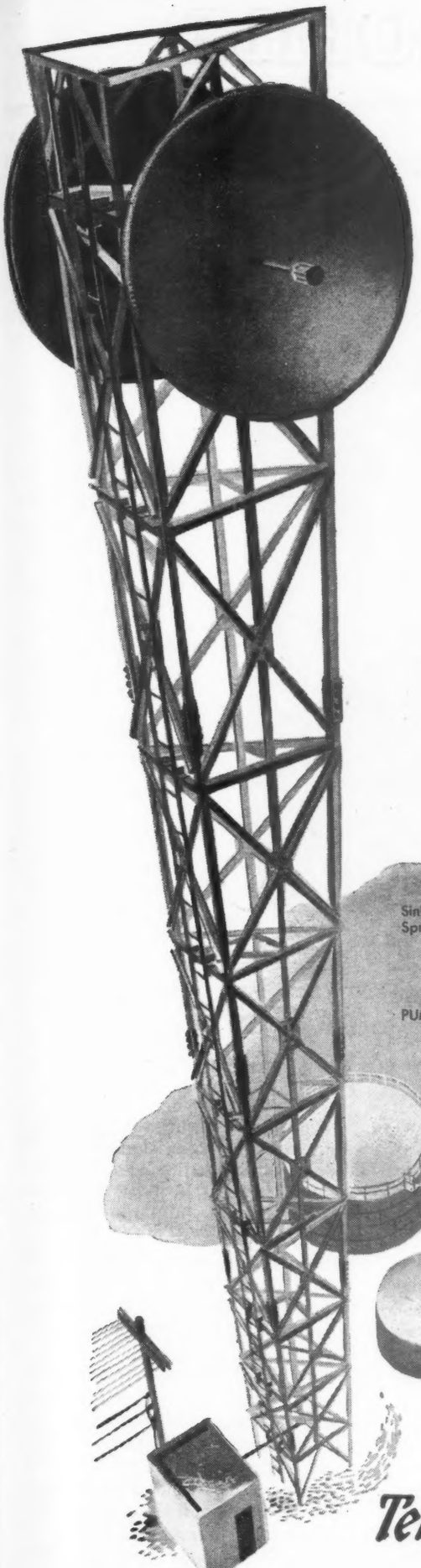
We in the West Coast oil industry face such a suit. My company and six other West Coast companies were made defendants in an action brought some months ago by the anti-trust division of the Department of Justice. Briefly, these companies are charged with conspiracy to restrain and monopolize trade in the oil industry on the Pacific Coast. In effect, the suit alleges there is no competition among oil companies. The claim is that, taken in total, their entire business adds up to a size large enough to control almost every type of operation from oil production to service station sales. This theory disregards the hard facts of competition between these companies and the other companies that comprise the industry.

The suit proposes to dismember the West Coast industry by asking that all crude oil pipe lines of these companies be made available to any other producer or refiner; likewise, tankers, barges, marine terminals, and storage facilities. Marine facilities owned by each company would be made available to any oil company. Further, the action seeks to destroy the defendant companies' ability to sell at retail or to retail outlets; we could sell only at refineries and marine terminals.

Now, I know, and I'm sure that those of you who are familiar with the oil industry know, that these charges simply are not true. The basis of these attacks on the oil business, and other basic industry, appears to be the ideological theory that bigness is automatically badness and must be smashed, no matter what the consequences to individual industries or to the economy and strength of the nation as a whole.

I see nothing inherently wrong with bigness in American business, providing of course that it does its job well and meets its obligations fully. I am very proud of my company, which is a "big" one in the oil business. I know that it serves its customers well, that it is a good citizen. I know also that it can do these things better by being big than small. I would like to close with an appropriate quotation from a recent public statement by Mr. T. S. Petersen, president of the largest Pacific Coast oil company, Standard Oil Company of California, who said:

> "Guaranteed the continuance of their freedom to produce for the needs of our country, the oil industry and all other industries the nation depends on so much will continue to make big plans and to carry them out. The pay off they can provide is prosperity in peace, and preparedness in case of war." * *



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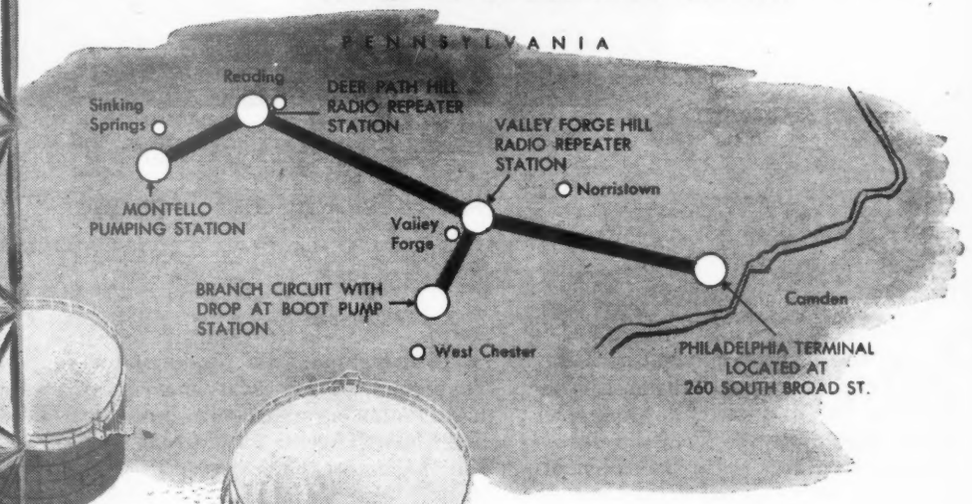

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PETROLEUM PROFILE

LESTER H. TRUE

Vice President and Manager

Magnolia Pipe Line Company

It was during the summer of 1921 when he was a lad of 18 that Les True received his first taste of pipe line work. Apparently he liked the flavor of pipelining because in December of the next year he signed the payroll as a regular employee with Magnolia for keeps. And the Magnolia organization apparently liked the way Les True did things. Twenty-three years later he was elected vice president and manager of pipe lines.

L. H. True's first job was as a time keeper in Arkansas, pretty far away from his home town of Temple, Texas, and from Midlothian, where he was reared. A year later found him a pipeliner in Oklahoma, where the company was doing construction work at the time. True's first real promotion was to that of gauger at Corsicana during the flush production of the second Powell field boom near there. Following transfers to Burkburnett, Electra, Archer City, Crane, and Wink as gauger, he advanced to chief scout in East Texas in 1931, during the early days of that field.

In July, 1934, True was promoted to district superintendent of the Luling pipe line district and on March 1, 1937, was made general superintendent of Texas, Louisiana, and Arkansas. A year later he was advanced to assistant manager of pipe lines and on March 13, 1945, was elected to the board of directors of the Magnolia Pipe Line Company. In October, 1945, he was elected vice president of the company and on January 1, 1946, he was appointed manager of pipe lines.

It was under True's supervision that Magnolia Pipe Line Company's 650-mile, 20-in. crude line was constructed in 1947 and 1948 from Corsicana, Texas, to Patoka, Illinois. This line, the longest crude oil pipe line constructed by a single company since the end of World War II, connects Magnolia's network of pipe lines in Oklahoma and Texas with its system in Illinois, Indiana, and Ohio.

True is a director of the Texas Utilities Company and a member of the Dallas Petroleum Engineers Club, and Dallas Athletic Club. The Trues live at 4831 Brookview in Dallas, where Mrs. True, the former Rose Virginia Sullivan, has a full time job keeping up with the numerous activities of their two teen-age sons and two younger daughters.

Will 44,000 wells be enough in 1951?

THE IMPORTANCE of our domestic crude oil supply—now about 6,000,000 bbl daily—is emphasized by the danger that the U.S. might lose most of the present 1,000,000 bbl daily imports in case of an all-out war, and thus face a serious shortage of some 250,000 to 750,000 bbl daily—even though we might be able to produce about 350,000 bbl daily more for a while (mostly from the oil wells of Texas). Demand for all oils is now about 7,600,000 bbl daily, or 15 per cent above the same period last year, and demand in 1950 was 11 per cent above 1949.

The drilling of 42,603 wells in the U.S. during 1950 did not increase the "sustained-reserve" daily producing capacity (or "pinched-in" producing capacity) by 1,000,000 bbl daily—and yet some people voice the hope that a 1,000,000-bbl-per day producing capacity may be achieved in 1951 by a 44,000-well drilling program.

Only 24,031 of 1950's wells were completed as oil producers. These would have to be capable of producing an average of about 42 bbl daily per well over a period of ten years (under the "most efficient rate" criteria for each producing reservoir)—to provide what is termed a "1,000,000-bbl daily sustained-reserve" producing capacity. It is very doubtful that 1950's oil wells are capable of producing more than about half that much (or 21 bbl daily per well) during the first ten years. This much production would be a significant contribution to the crude oil supply, amounting to 500,000 bbl daily during the first ten years, or 1,825,000,000 bbl. The rest of the 3,500,000,000-bbl addition to crude oil reserves by discoveries and revision of estimates during 1950 might take from 20 to 60 years to produce on a declining basis. In short, the discoveries and additions to "reserve" are not available during the first ten year period.

It is obvious that the 1950 drilling program was a signal success by all previous standards of measurement, but it could not provide a 1,000,000-bbl "cushion" to our producing capacity in the face of increasing demand. A 44,000-well program in 1951 cannot be expected to do much better than meet the increased demand. The drilling industry should be allocated all the steel it can use in the U.S. and Canada during 1951, if the U.S. is to have the "sustained-reserve" daily producing capacity it may need in the event of an all-out war.—KMF

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BAKER MODEL "D" RETAINER PRODUCTION PACKER PRODUCT NO. 415-D

We realize that your choice of setting method is important, but before we consider the relative advantages of setting methods, let's first analyze the end results obtainable with these tools after they are set.

Among the important advantages of the Baker Retainer Production Packer are its uses . . . for production of one or more zones, simultaneously or separately, for acidizing, for re-pressuring—in fact for every application possible for a packer of its type.

Features which appeal to veteran production men are its Complete Drillability—Resistance to High Temperatures—Corrosion-Resistant Construction—Freedom of the Tubing from the Packer—and Positive Anchoring against Upward or Downward Movement—Bottom-Hole Control with a flapper valve which closes when the tubing is removed, thereby eliminating necessity for killing the well with mud, under normal well conditions.

The wide range of applications, permitting almost unlimited flexibility of subsequent operations, is based upon the construction of the packer itself which employs two sets of opposing slips with a Buna N Rubber packing element between them. When it is set the Packer virtually becomes a part of the casing, cannot be moved up or down, and prevents fluid or gas from passing between the packing element and the casing.

When the Setting Tool (used to set the Packer) is removed from the well, only the smooth-bore Packer remains, securely packed-off, ready for selection and use of the proper Baker Packer Accessory Equipment to meet your production requirements.

It is the extensive line of Accessory Equipment which permits installations to produce from one or more zones, as desired, through tubing or casing—and production changes often can be made without pulling the production string. Complete details of hook-ups, and illustrations of many unique, as well as routine installations, are contained in an 84-page Baker Packer Brochure, gladly sent to you upon request.

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Improvements in Metallurgy and Design Reduce Failures of Drill String Tools

FRANK BRIGGS

COMMON failures in such "rounds" as drill collars, drill pipe, tool joints, and safety joints should be, and are fast becoming, unusual. It is known that better design and improved manufacturing processes have made large contributions toward this end. What is less widely known is the part that metallurgy and heat-treating have played in collaborating with the above factors to make deep drilling possible and economical. This has been accomplished through more rigid specifications in purchasing steel, selection of the proper alloy steel for the job to be done by the finished product, and rigid inspection of the steel both in structure and in heat treatment.

Consider the purchase specifications. Not too many years ago, steel was "iron" to the oilfield and it either "held together" or failed. Alloy steels came to be recognized gradually as materials for giving strength, hardness, or durability to oil tools. As deeper drilling progressed, however, the requirements placed on steel products became greater, and many failures occurred until design and metallurgy made greater contributions. For instance, it was found necessary to predict the hardness and strength of newly designed tools at all points of a bodily cross-section. Consequently, new standards were set up for steels in critical service (and what oilfield tools may not work in service at the limit of their strength?), and the ability of the steels to harden under heat-treatment was measured. This, as the name implies, was termed "hardenability".

Hardenability is now more or less a yardstick for judging the character of the steel. To see how this fits into the picture, consider the drill string member known as the "safety joint." This tool is made most commonly from heavy-wall tubing, perhaps with a wall thickness as great as two inches. The critical part of this and other tools is the threads: Failures occur most frequently through a cross-section of the threads. Consequently, the portion of the tubing where the threads are to be cut should have proper strength and hardness. As one is directly proportional to the other, we will merely designate the proper hardness for this zone. Although the outside diameter has the proper hardness, one cannot say that the same hardness will apply to the steel about an inch within the wall body where the threads are cut. In fact, one can reasonably be certain that the hardness will not be the same.

FIG. 1. This joint is typical of fatigue failure; it simply could not endure the service to which it was subjected.

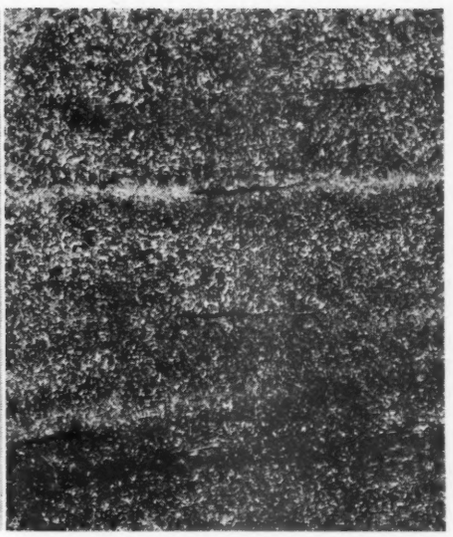


FIG. 2. Photomicrograph of the steel structure of joint showed banding and inclusion stringers; matrix is typical of low ductility.

It was desirable, therefore, to find a measuring stick to set up standards for this process. Accordingly, the American Iron and Steel Institute adopted a round bar 1-in. in diam and 2-in. in length as the "standard end-quench bar." This specimen of the steel under test is heated to a certain temperature and quenched only on one end by a cooling spray of water. A hardness survey over the entire length of the bar then determines its hardenability, readings being taken in 1/8-in. increments from the quenched end. As it is not commercially feasible to hold these specifications to exact hardness, band limits are specified and hardness readings are to fall within certain tolerances. A typical band limit is shown in Fig. 3.

As for selecting the proper steels for the job to be accomplished, many drill string tools are made of the chromium-molybdenum alloy steel designated as 4140 or 4142. This is excellent steel for tool bodies; it is tough, ductile, and very responsive to heat treatment. The general useage range of heat-treat hardness of this steel is from 285 to 321 Brinell, which at 300 Brinell produces a tensile strength of about 155,000 psi.

Molybdenum as an alloy additive imparts to the steel its ability to respond easily to heat treatment. The 46XX series steels have high nickel content and usually a low amount of carbon. The steel designated as 4620 or 4615 is used principally where the part requires a hard carburized surface with a ductile core. Such tool parts as gears, axles, pins, roller bearings, bolts, studs, slips, etc. where extreme wear under heavy loads are encountered are made from this type.

Because of the walls and large cross-sections, most drill collars and other large tools of this nature do not require the alloy steels for their manufacture. These items are usually a modified form of carbon steel with good impact qualities.

In many instances of tool failures, the cause is invariably connected with the service history; if that is known,

EXCLUSIVE

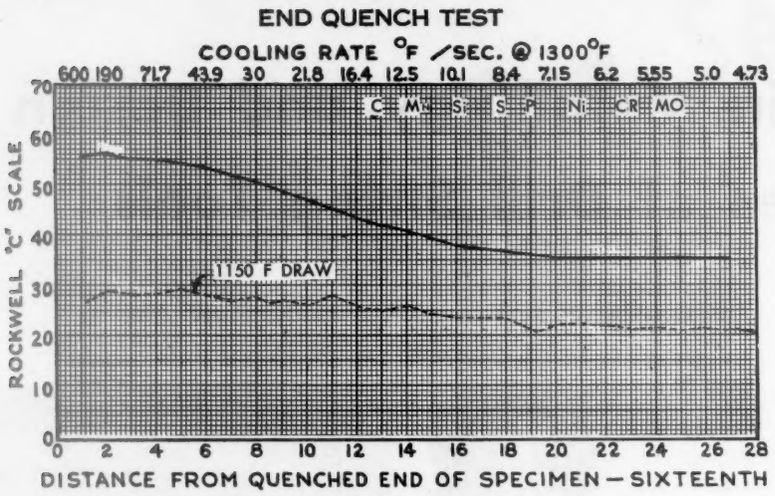

END QUENCH TEST
COOLING RATE °F /SEC. @ 1300°F
600 190 71.7 43.9 30 21.8 16.4 12.5 10.1 8.4 7.15 6.2 5.55 5.0 4.73
C Mn Si S P Ni CR MO
1150 F DRAW
ROCKWELL 'C' SCALE
70 60 50 40 30 20 10 0
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28
DISTANCE FROM QUENCHED END OF SPECIMEN — SIXTEENTH

FIG. 3. The hardenability test on steel in Fig. 1 and 2 shows proper specifications for this 4140 material of 45 to 55 Rockwell "C" hardness at 8/16ths distance on the specimen bar.

the reason for failure is obvious. In a diminishing number of cases, the microscope and testing machines may be required to ascertain the hidden facts of defective material or workmanship. A visual examination of the failed member often provides a clue. The accompanying illustrations are examples of defective material and poor shop inspection, or very poor field practices. In each case, a lesson was learned and not repeated. The product failures shown are in no way representative of the manufacture or of the tools as they are made and used today. These photographs, photo-micrographs, photo-macrographs, and sketches are presented as examples of what can happen to such tool bodies, to awaken the detective instinct in personel having failures in drilling aid in the elimination of practices responsible for tool failures.

Safety Joint

This member of the drill string deserves especial attention, because of its part, both vital and severe from a service standpoint, in the successful drilling of wells. It is vital, because it is the means by which the drill pipe may be released and removed from the hole should the larger drill collars and bit, which are below it, become stuck. The service it receives is most severe, because it is the adapter between the drill pipe and the drill collars—often connecting the two. It is generally conceded that the best practice is to run the safety joint one stand above the collars—thus putting the excessive fatigue at the top of the drill collars upon the less vulnerable tool joints of the drill pipe.

Safety joints fail in two ways: Strength and performance. Fig. 1 is typical of physical strength failure. This may be called excessive fatigue. Examination of the cross-section of failure clearly shows fatigue, or rings of cold working, around two-thirds of the section. During the latter stages of its service, the "tear-drop" or tension failure portion alone joined the two sections together. Of course, the natural thought is that excessive stress concentration existed at the releasing thread and was responsible for the ultimate fatigue crack and resulting failure. True or not, the manufacturer changed the design of this thread to distribute high torque loadings more evenly. Metallurgical examination revealed a possible failure factor in the heavy banding and inclusion stringers of the steel itself. This is quite a controversial subject, many people believe banding has no effect upon the fatigue or endurance limits of steel and many others point out a number of failures in equipment manufactured from banded steel. Fig. 2, a photo-micrograph of a section of the safety joint in Fig. 1, magnified and etched, clearly shows this banding characteristic. It should suffice to say that most manufacturers strive to use unbanded steel in their products.

This particular failure was further subjected to the "hardenability" test for a determination of its "personality" in response to heat-treatment. For its type of alloy steel (4140, 3140), it met the recommended 45 to 55 Rockwell "C" hardness at 8/16ths distance from the end of the tested specimen.

Another example of the application of excessive torque to safety joints resulting in failure may be seen in Fig. 4. In this case, the clutch, or releasing face, fractured as shown within the chalk mark on the specimen. This clutch is composed of three crested points, 120 deg apart around the periphery; the torque load is carried on the "hillside" of each crest, thus making shoulder contact on only half of the section. This fact gives it the ability to release upon reverse rotation before any other member of the drill string. Physical and metallurgical examination revealed good steel, poor design. The manufacturer increased the shoulder thickness, reduced the pitch of the crest and thereby eliminated completely failures of this type. Fig. 5 shows the structure

FIG. 4. This fracture resulted from excessive drilling torque; more shoulder thickness and less pitch of the clutch faces eliminated trouble.

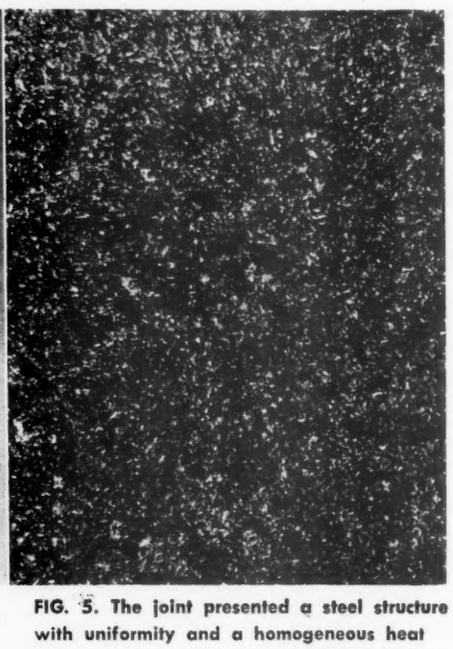


FIG. 5. The joint presented a steel structure with uniformity and a homogeneous heat treatment. This hardness was 302 Brinell.

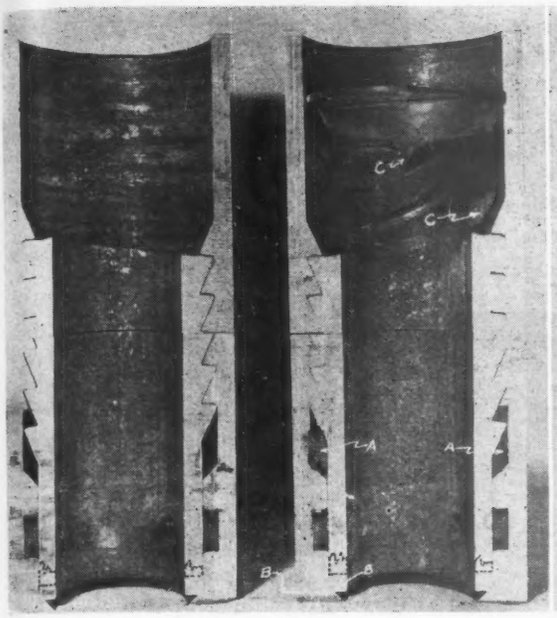


FIG. 6. The releasibility of this joint was impaired by a misplaced pack-off rubber and also the fact that the releasing stem had excessive length.

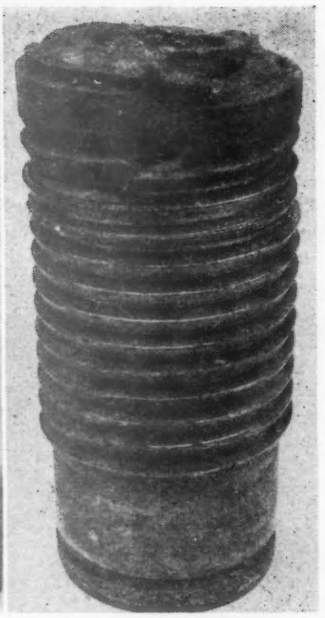


FIG. 7. Just one of those things: No discernible cause for failure. Service history might tell.

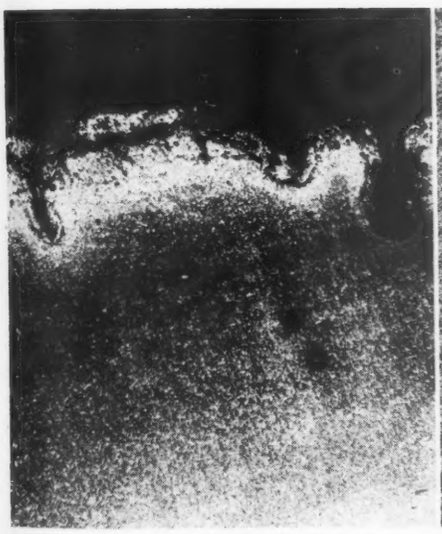


FIG. 8. Another shows adequate cause for failure: Photomicrograph of structure indicates carburized case and surface cracks.

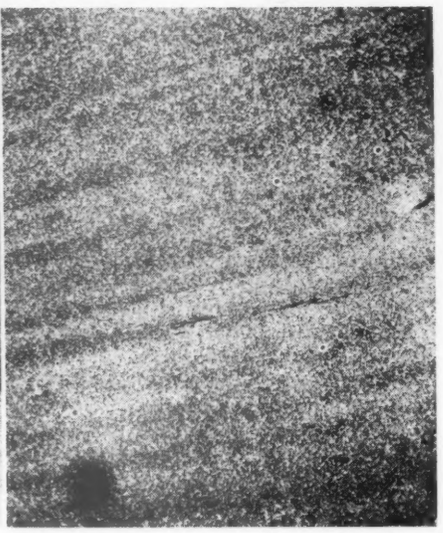


FIG. 9. Also banded structure and inclusion cracks are detected at core.

of the steel in this joint. It is a uniform steel with homogeneous acceptance of heat-treatment.

A combination of poor field practice and a serious manufacturing error is illustrated in the failure of the safety joint shown in Fig. 6. In this case, the joint failed to release on bottom; when brought to the surface, the drilling crew twisted it off with tongs and cathead. Clearly shown in the split joint is the misplaced pack-off rubber (put there by the crew while dressing the tool) designated by "A." The excessive extension of the releasing stem contacting the tool body is shown at "B." These two factors bound the members rigidly and continued to hold even though the stem was twisted off with reverse torque.

Occasionally a failure will occur and no definite responsibility can be placed. Such is the case of Fig. 7. Failure here appears to be due to a sudden (and not repeated) twisting load rather than fatigue. Metallurgically, the steel was good.

Photo-micrographs of a safety joint failure caused entirely by poor steel structure is illustrated in Figs. 8 and 9. Failure was attributed to a combination of heat treating defects and banded structure.

Sometimes the tenacity of steel to resist fracture, because of proper heat-treatment and hardness, is cause of one type of failure. Fig. 10 is a side view (with the joint shoulder at the top of the photograph) wherein excessive torque loading moved the mass of steel to form three upset points on the clutch faces. In view of the proper hardness, steel structure and quality, the only conclusion to be drawn from this failure was that the load applied on the three portions of the joint shoulder exceeded the allowable compressive stress.

The only justifiable failure is the one caused by a "freak" condition. Such an example is shown in Fig. 11. This specimen failed through a fissure in the steel opening under pressure and gradually causing a wash-out of the joint. This sample was acid etched and examined microscopically; no other defects were found. A localized, freakish crack was responsible.

Fig. 13 shows a safety point that fractured in the box conection. The laboratory ran a hardness survey over

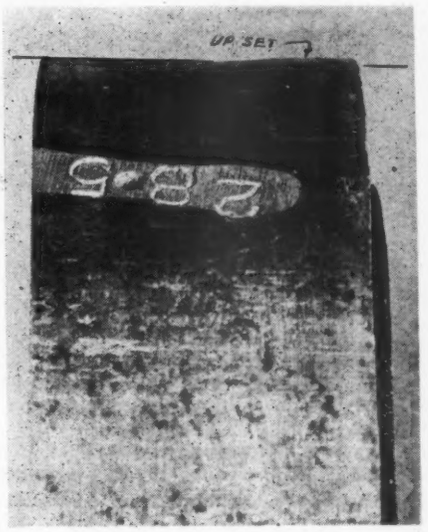


FIG. 10. This joint indicated a hardness on the low side of specifications; this could have been responsible for cold worked shoulder.

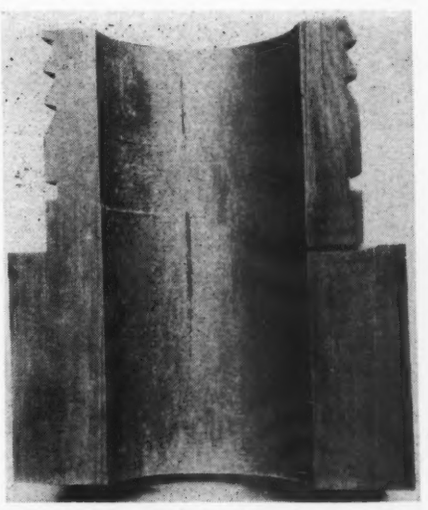
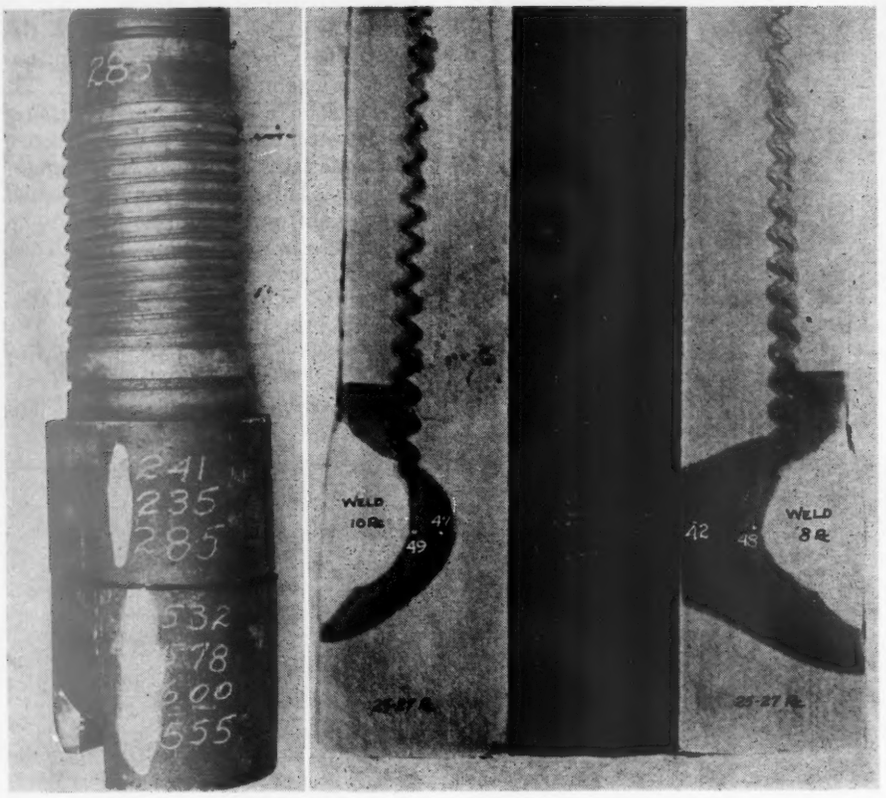


FIG. 11. Split joint shows wash-out resulting from crack caused by flaw in steel.

FIG. 12. Photomicrograph of structure of crack at inside surface.

FIG. 13. A hardness survey clearly shows the culprit involved in this failure: The guy who put the welding torch on the box end.

FIG. 14. Poor thread engagement, bad welding practice and improper hardness are clearly shown in this tool joint failure.



the entire length of the failure member. The results are as shown printed in chalk on the piece. The end above the failure indicated as high as 600 Brinell compared with 285 below. This extreme and localized hardness could only have been obtained in the field after manufacture, because the lathe could not cut material of this hardness. For some unaccountable reason, an acetylene torch was applied in the field to the region of the box; it air cooled to this hardness.

Drill Pipe and Tool Joints

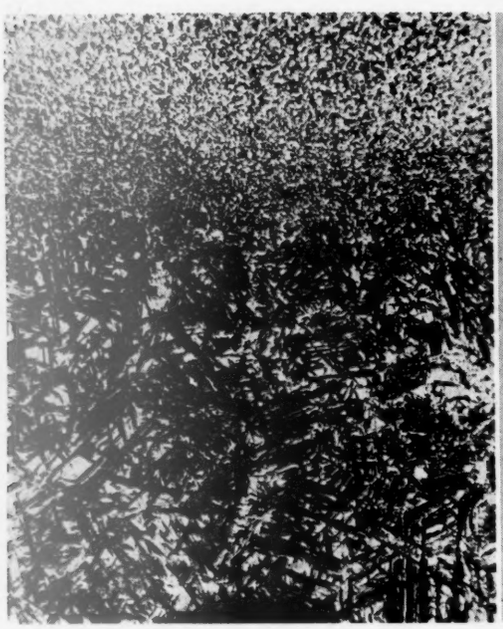
Many excellent papers have been prepared on conventional drill pipe and tool joint failures; this will merely illustrate a typical failure or two in the fishing and cutting strings, and in a wash pipe.

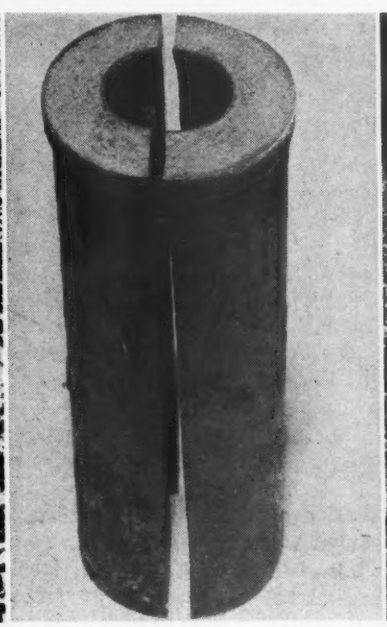
Fishing and cutting pipe are usually

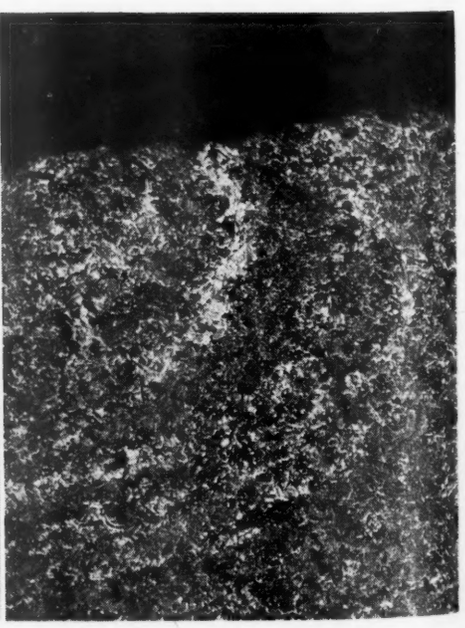
FIG. 15. This photomicrograph of the junction between the weld metal and the base metal (or heat affected zone) shows a brittle martinsitic structure.

FIG. 16. This pressure welded joint shows a smooth break between pipe and joint; not enough welding heat to completely fuse two metals.

FIG. 17. Microscope on same joint failed to locate presence of detrimental oxides. Structure is heterogeneous in composition.







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designated by tool joint size. Conventional sizes are $1\frac{1}{16}$-in. or $2\frac{7}{8}$-in. OD. The tool joints are threaded, made up tightly on the pipe, and welded by rod to the joint. Fig. 14 is a photomacrograph of a joint failure split longitudinally that reveals not only poor thread contact and maladjusted loading, but also the heat-affected zones around the bead weld. On the right is a large area and on the left, a small area; it is easy to see that the welding began on the left, for the base metal was cold and thus absorbed the heat in a smaller area. Also, the Rockwell hardness readings have a wide range from that of the bead, the heat-affected area, and the base metal. The micrograph of the junction, Fig. 15, shows the coarse structure of the grain; this is most susceptible to fractures under stress.

Almost all of these small service strings are joined to their tool joints by the pressure-welding or arc welding processes. These eliminate many of the short comings of the old bead weld method. Using the pressure-welding method, one manufacturer experienced only two failures out of 30,000 joints welded. One of those failures is shown in Fig. 16. This shows that the break occurred in the junction between the tool joint and the drill pipe. The reason is obvious; this juncture was not sufficiently hot for the two metals to fuse properly when forced together under pressure. A cooling slug of wet acetylene gas may have been responsible. This is most unusual, and the reason for the effectiveness of this method is the mechanical control of all factors and the rigid destructive inspection applied periodically.

Wash pipe (or more properly, wash-over pipe) very often twists off under severe service. In some instances, the constant rubbing of the pipe walls against the "fish" may create great friction and considerable heat, even though immersed in the drilling mud. Such heat may cause localized heat checks in the steel. Fractures and failures are the end result. Fig. 18 is a photomicrograph of such a failure.

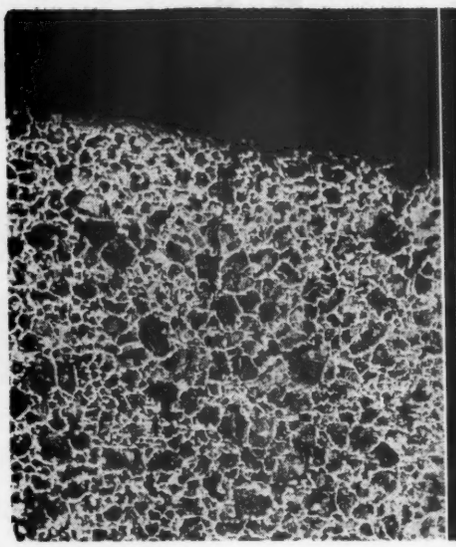


FIG. 18. Wash pipe in service occasionally generates enough frictional heat to cause failure; this photomicrograph of the outside surface shows heat crack .010 in. deep.

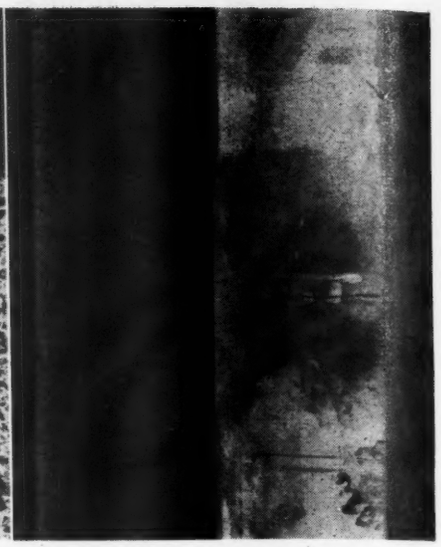


FIG. 19. Magnetic particles outline the surface crack in this cracked drill collar.

Drill Collars

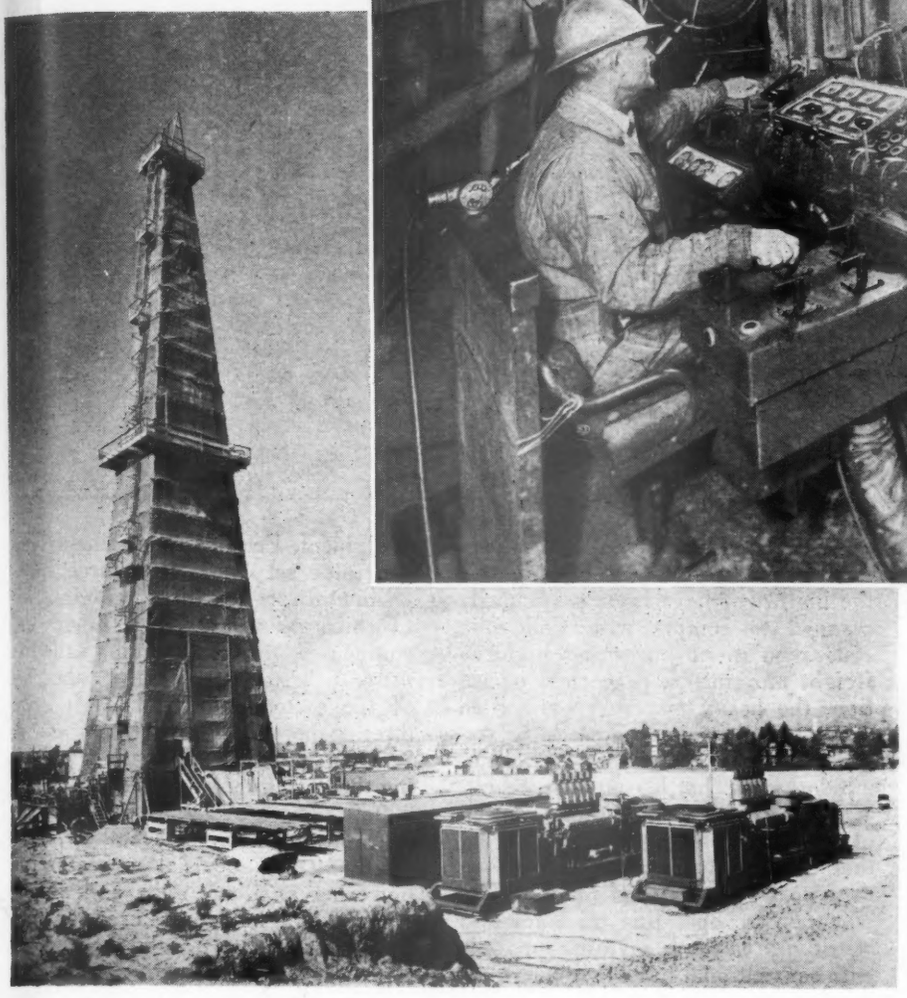
Drill collar failures have been reduced greatly by careful attention to thread design and close inspection to see that manufacturing processes are not lacking. New shape threads, greater cross-sectional area for fatigue resistance, cold working by rolling the thread base, and thread milling or grinding for uniformity have contributed to the reduction of failures in drill collars. Careful field inspection should be added; it has prevented many a failure from occurring in the hole. Such a potential failure is shown in Fig. 19. This drill collar was racked for magnetic particle inspection; the crack in the body is revealed by the accumulation of powdered metal. From a study of the crack and a microscopic examination (Fig. 20) of the steel structure, it was thought that mill practice was responsible for the formation of cooling cracks. A metallurgist believed the defects were not the result of heat treating procedure, however, because of their discontinuous and random nature. The fact that the crack is narrower at the surface than further in, indicated that the defect was in the steel in the "as received" condition.

Banding in steels may or may not be detrimental from a strength standpoint; however, when the alternating layers or bands vary in machinability, trouble of a galling nature may be encountered. Consider the photomicrograph, Fig. 21. It was obtained from the pin of a galled drill collar. The light etching constituent is steel low in alloying elements; it machines poorly. The darker band machines better. Consequently, one band might have been torn rather than chipped during machining, and the other band would have been machined properly. Thus, an alternate rough and smooth surface might have been present on the thread. In service, it galled with the mating member. * * *

FIG. 20. This is how a thread crack looks under 100 magnifications. It extended about ½ in. deep in drill collar.

FIG. 21. Photomicrograph of core of drill collar shows banded areas.

Looking across derrick floor from driller's console.



Standard Oil Company of California's new diesel electric rig drilling its first hole. Derrick is 162 ft high and is fully insulated.

P 425.23

Ultra-Modern Diesel Electric Rig Combines Flexibility and Portability

RICHARD SNEDDON*

ATTRACTING considerable attention among west coast drilling men at the present time is an outsize diesel-electric drilling rig now operating in the Baldwin Hills area of Los Angeles County for Standard Oil Company of California. This is one of the largest and most modern assemblies of its kind attempted up to the moment. It requires no outside source of power; operates on self-generated d-c electricity; has the drawworks set at ground level below the derrick floor; is well insulated and ventilated; and, despite its size, has an unusual measure of flexibility and portability. Although capable of drilling to 20,000 ft, the rig can efficiently and economically handle the more commonly required 8000 to 12,000-ft holes, and it incorporates so many innovations that it virtually heralds a new era in drilling equipment design.

EXCLUSIVE

Originally conceived by Standard of California engineers, the rig represents a long forward step in a program having as its objective conversion from steam to more convenient and economical internal combustion engine power. It cost some $400,000, exclusive of drill pipe, derrick, substructure, etc., and involved the use of a drawworks from an idle rig, and

*Pacific Coast editor.

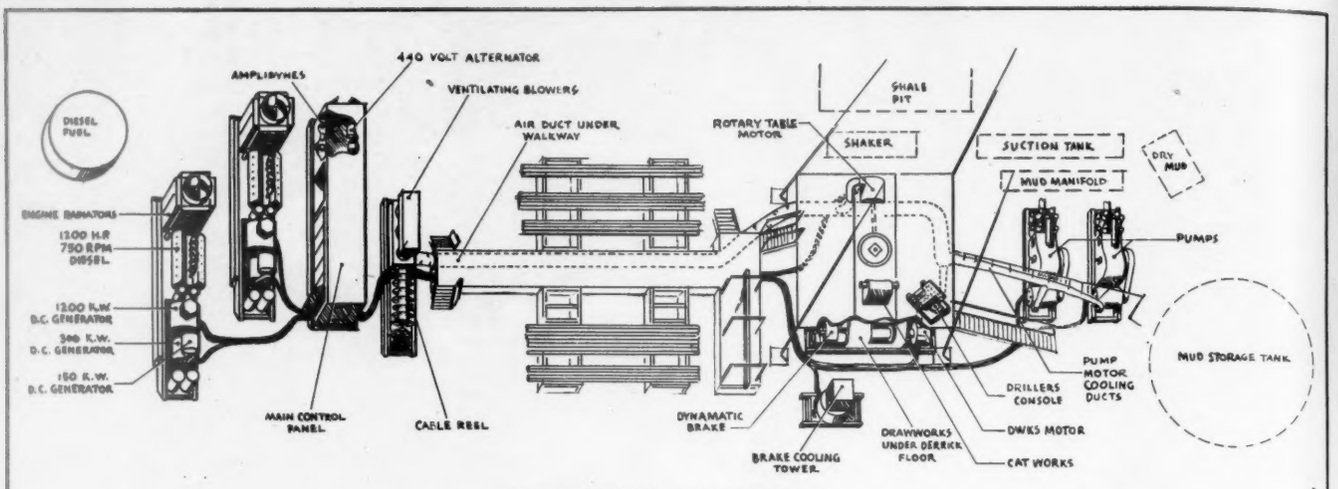


DIAGRAM OF LAYOUT PLAN

six generators and four direct current motors, salvaged from World War II marine stock. It is estimated that to duplicate the set-up today would require an approximate outlay of $700,000. It was designed, manufactured, and assembled by Emsco Derrick and Equipment Company, in cooperation with General Electric Company and other equipment manufacturers, from basic ideas furnished by Standard. The latter was aided in its plans by consultant, J. E. Lucas.

The purposes behind the development were to obtain greater portability in a deep-drilling rig, to improve operating characteristics, and to lower maintenance costs. All mechanical and electrical units in the assembly are mounted on skids and are completely self-contained so that rigging-up, tearing-down, and moving operations are facilitated and expedited. The various packages—11 when moving over the highway—have been particularly planned to comply with California state regulations governing highway freight movements. In normal operation, the heavy machinery is set on ground level, which increases the stability and considerably simplifies moving when that becomes necessary. It is, of course, also the expectation of those responsible for the big rig that the direct current motor-driven drawworks, rotary, and mud pumps, will increase operating efficiency and sensitivity beyond anything possible with conventional power rigs or steam drawworks.

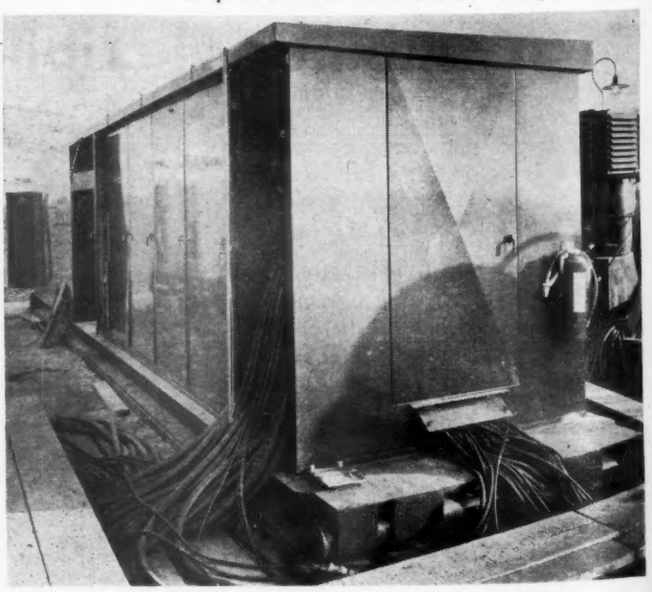
Two 1200-hp, diesel engines drive direct current generators to provide electric power for drawworks, rotary, mud pumps, and other auxiliary equipment. Each diesel engine-driven generator set consists of three independent direct-current generators, two of which are mounted in line with the engine power-take-off clutch, while the third is "v"-belt driven from the end of the second generator shaft. The three generators are as follows: A 1200-kw, 525-volt generator for driving the drawworks and mud pumps; a 300-kw, 230-volt generator for driving the rotary table; and a 150-kw, 125-volt, constant potential generator for powering auxiliary units and amplidynes, which in turn are used for field excitation of the two larger generators.

During normal drilling operations, either of the two 1200-kw main generators is used to drive a mud pump motor, and either of the two 300-kw generators is used for the rotary table

This drilling rig was engineered, manufactured, and assembled by
EMSCO DERRICK & EQUIPMENT COMPANY
In cooperation with
GENERAL ELECTRIC CO.
CLEVELAND DIESEL ENGINE DIV. OF GENERAL MOTORS CORP.
MORSE CHAIN COMPANY
JACKSON ENGINEERING COMPANY
In accordance with basic ideas
STANDARD OIL COMPANY OF CALIF.

Close-up of driller's console. All controls are centralized in this compact, skid-mounted unit. Finger-tip operation is provided by complete electric and pneumatic controls.

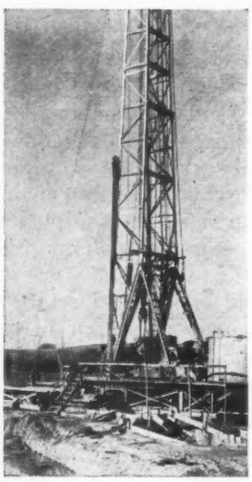
Main control panel package houses control and transfer switches, contractors, relays, amplidynes, alternators, etc. Control panel is air pressurized to prevent dust in electrical compartments.



N.4

DRAWWORKS for 5500′ drilling

Millions of feet and not a Whimper!



One of the Brewster N-4 Teams operating on drilling programs in Alberta's Leduc and Redwater fields.

BREWSTER N-4 DRAWWORKS
For drilling 3500′ to 5500′ with 4½″ pipe.
Single or double drum models with one or two engines.
Single engine model equipped with torque converter.
Two engine model equipped with 4-speed transmission and oil bath compound with pump drive.
This unit has portability . . . speed . . . economy . . . flexibility . . . and "Brewster" quick field service where and when needed.

. . . That's the record of the Brewster N-4 all the way from Texas to Canada. Millions of feet of low-cost hole—and smooth year-round drilling without a whimper.

It's a tough piece of iron, the N-4, with a reputation for getting the hole down fast and saving the driller money.

Your supply house can tell you about the N-4 . . . or write to us direct.

The Brewster Company, Shreveport, Louisiana.

Brewster Drilling Equipment sold by:

Apex Equipment Co.
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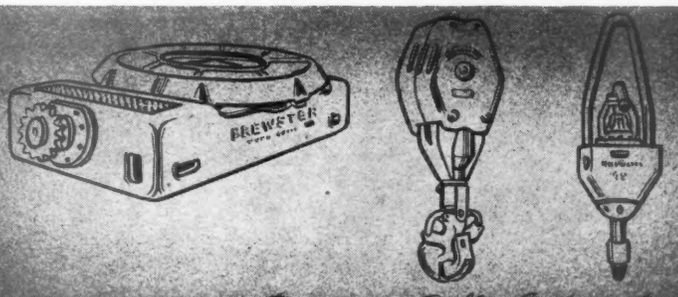
In Canada: Rocky Mountain Supply Co.
Export Sales: Direct and through recognized export dealers.

Brewster MATCHED drilling equipment for the N-4 drawworks includes the RS-18 Oilbath Rotary, the Model H-11 Hook Block and the 4-S Oilbath Swivel.



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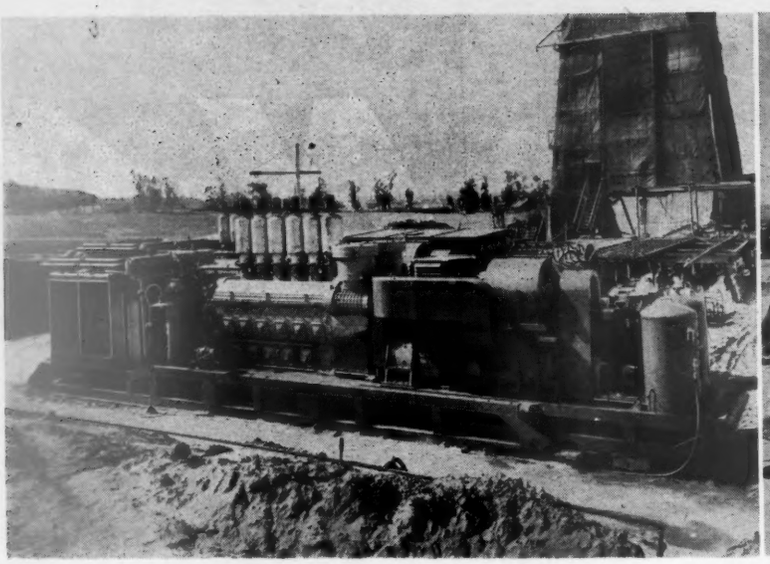
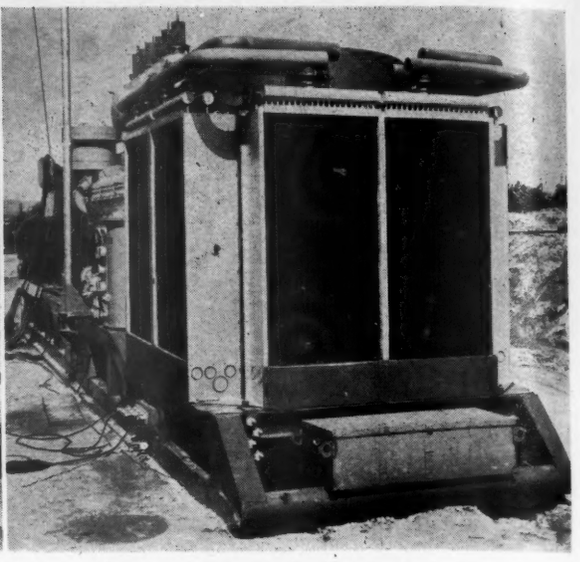


Close-up of No. 1 diesel engine driven generator set. Three independent direct current generators are driven by engine; two on an extension of the engine power take-off clutch shaft and the third V-belt driven from the same shaft.



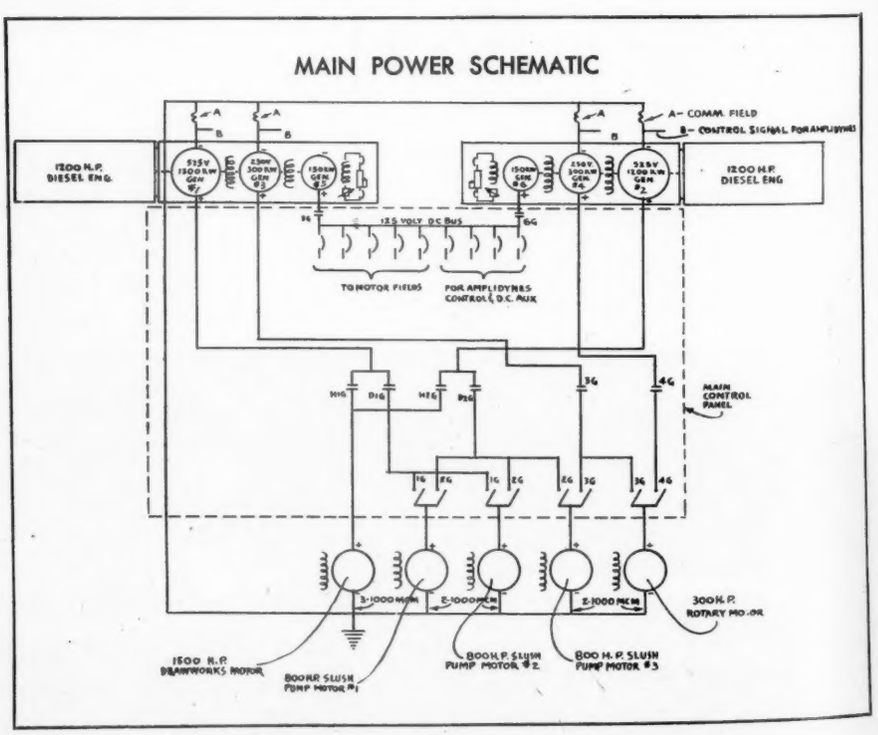
Unique dual radiator cools diesel engines and engine lubricating oil. A fan is mounted at the top of the dual radiator unit and is driven by the engine.

motor. For hoisting service, the two 1200-kw units are operated in parallel to drive the 1400-hp drawworks motor. In terms of high gear, fast line pull this provides 29,000 lb for accelerating, and with 8 lines strung, approximately 10,000 ft of 4½-in. drill pipe can be started from bottom in high. During operation, the rig is exceptionally quiet and free of vibration. The driller is seated at a control console facing the rotary table and has an unobstructed view of the derrick floor. The derrick floor is clear of all equipment except console, catworks, and rotary machine table top. The use of direct current motors provides rapid and smooth acceleration of loads, with absolute control of speed and torque.

One of the most unusual of the innovations already mentioned is the setting of the drawworks at ground level under the derrick floor, which eliminates the need for a heavy substructure to support the unit. In order to keep the drum fast line within the confines of the derrick, the position of the drawworks has been rotated 180 deg. Thus, the front of the drawworks actually faces away from the center of the well.

The drawworks is a 2-shaft, 2-speed unit, driven by an enclosed, fresh air ventilated, 1500-hp, 525-volt 600-rpm direct current motor. A direct air-operated friction clutch is provided on the high speed drive, and, because of space limitations, an air-operated jaw-type clutch for the low speed drive. It is expected that the low speed drive will be seldom used. The drum is 32-in. in diameter by 57⅝ ft long and is grooved for 1⅜ in. wire line. The low gear pull of 75,000 lb on the fast line will handle a maximum hook load of 750,000 lb with 10 lines strung. Brake rims are 62 in. in diameter and are individually cooled by a forced water circulating system. A unique air system is provided for operating the drawworks brakes from the console on the derrick floor. The brakes are 100 per cent air operated, but a spring-loaded brake is also provided for emergency use. This latter may be operated by the driller when necessary and is automatically applied if the air pressure falls below 80 psi. The drawworks is also equipped with a 60-in. dynamatic electric brake.

All controls are manipulated in a compact, skid-mounted console set on the derrick floor. The use of both pneumatic and electric controls permits fingertip operation of the complete rig. In addition to the conventional air controls for drawworks clutches, cathead, air slips, etc., electrical magnetic contractors are provided for selecting the various gener-


MAIN POWER SCHEMATIC
A- COMM. FIELD
B- CONTROL SIGNAL FOR AMPLIDYNES
1200 H.P. DIESEL ENG.
1200 H.P. DIESEL ENG
525V 1500 KW GEN #1
230V 300 KW GEN #3
150 KW GEN #5
150 KW GEN #6
230V 300 KW GEN #4
525V 1200 KW GEN #2
125 VOLT D.C. BUS
TO MOTOR FIELDS
FOR AMPLIDYNES CONTROL & D.C. AUX.
MAIN CONTROL PANEL
1500 H.P. DRAWWORKS MOTOR
800 H.P. SLUSH PUMP MOTOR #1
800 H.P. SLUSH PUMP MOTOR #2
800 H.P. SLUSH PUMP MOTOR #3
300 H.P. ROTARY MOTOR

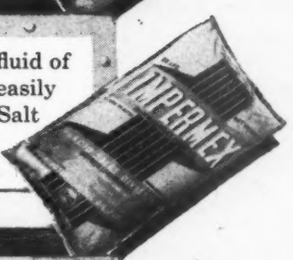
Mud ain't no baked potato!

Salt don't help it any...

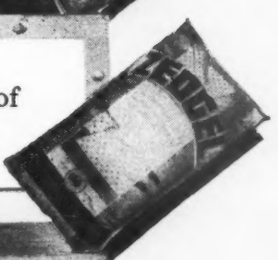
These Baroid Products Combat Salt

BAROCO
Operators find this inexpensive, salt-resistant high yield drilling clay ideal for use in drilling fluids exposed to moderate salt contamination.

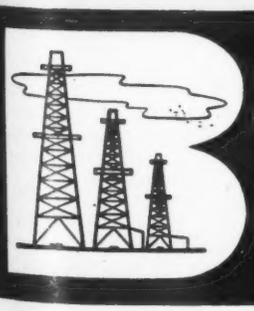
BAROID EMULSION MUD. An oil emulsion drilling fluid of exceptional stability, excellent lubricating properties and easily controlled viscosity, gel and water-loss characteristics. Salt and other contaminants do not affect the oil emulsion drilling fluid when it is properly compounded.



IMPERMEX
This organic colloid provides drilling fluids of exceptionally low water-loss, regardless of the salt concentration.



ZEOGEL
This special clay gives stable drilling fluids no matter how high the salt concentration. Addition of Impermex will provide low water-loss characteristics to the mud.



Baroid

BAROID SALES DIVISION
NATIONAL LEAD COMPANY
LOS ANGELES · TULSA · HOUSTON

Complete Drilling Mud Service

ator drive combinations. The driller may start, stop, accelerate, and switch rotary and drawwork's drives at will, and may select either 300-kw generator for the rotary table drive. Speed control switches are at the driller's position in fresh air pressurized units. Full motor horsepower is available over a wide range of speeds. Each of the various controllers has an infinite number of speeds from zero to maximum, forward and reverse, which insures instantaneous, accurately controlled speed changes. This is particularly advantageous for the shaft-driven rotary table where speed and torque can be measured and adjusted to changing drilling conditions.

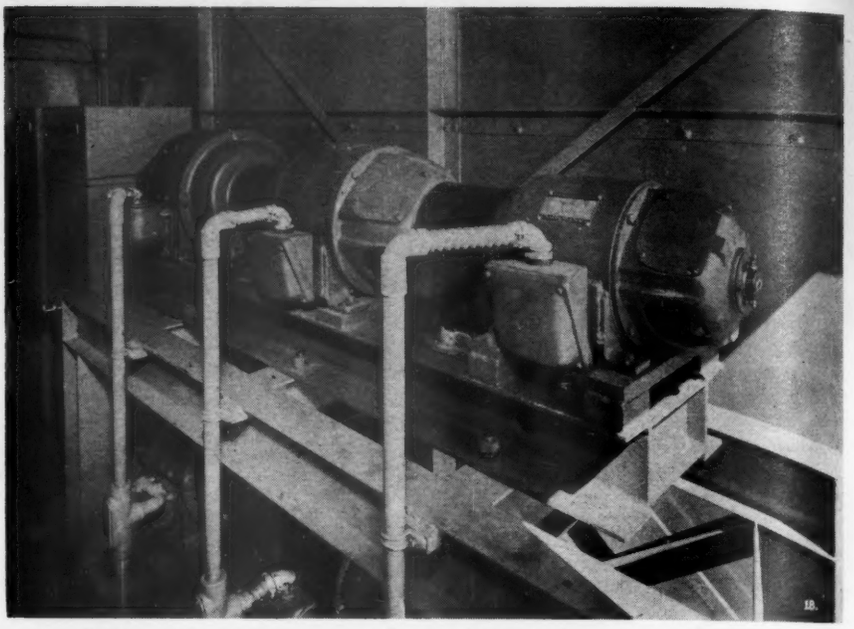
Either of the two 500-hp slush pumps may be stopped at the driller's position. For safety reasons, however, restarting and controlling speed, are done only at the mud-pump master switch position. The mud pumps are driven by enclosed fresh air ventilated 765 hp, 500-volt 1120-rpm d-c motors, and are mounted on a common skid base with the slush pumps. The latter are driven with a silent chain designed for high speed, heavy duty applications. It provides an extremely high load capacity per unit of width in addition to greatly minimizing shock loading of chain links. It almost completely eliminates noise, vibration, and heating. In operation, this new chain drive provides extremely quiet and efficient power transmission. It is employed on the drawworks shaft drives and also on the mud pump motor drives.

The use of direct current electric motor driven slush pumps is expected to reduce considerably pump maintenance. Amplidyne control of the direct current motor gives a dropping speed characteristic that is ideal for slush pump service. Preset maximum torque of the mud pump motors will cause the slush pumps to slow down and stall in case of excessive pressure caused by clogged bit or other restriction of the circulating system. This protects the fluid end from excessive pressures and prevents damage to the power end.

The use of diesel electric power provides many savings in time required for rigging-up and tear-down operations. The power generating and control units may be set in the most advantageous location. This minimizes excavation work for the alignment of related units when rig is operating in hilly terrain. It is unnecessary to dismantle any chain drives when moving.

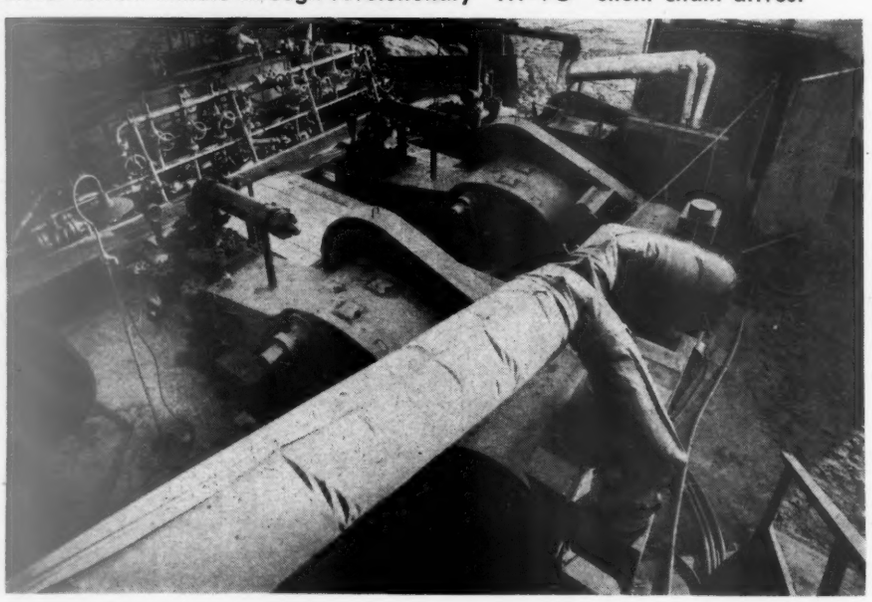
A large air-motor-driven reel is provided for reeling and transporting the electrical cables. Electrical connections between generators, controls and motors are made quickly and easily in the field. Cables are numbered and coded to facilitate correct coupling, and are equipped with indexing pins to assure correct installation on terminals.

The complete power plant and drilling machinery are assembled on skid-mounted bases. When moving from one location to another in the oil fields, the engine-generator set will be moved as one unit (total weight approximately 96,000 lb). Permanent alignment is assured between the two units by means of 4 tapered cones. The engine generator units are designed to set on wood beam mats thus eliminating the need for concrete base. The dynamatic brake and drawworks motor are removed from the drawworks package when it is necessary to keep this unit within road-weight limitations. When moving without limitation the number of packages for the equipment is eight: Two engine generator sets, one electrical control panel, one drawworks with motor and brake, one rotary unit,



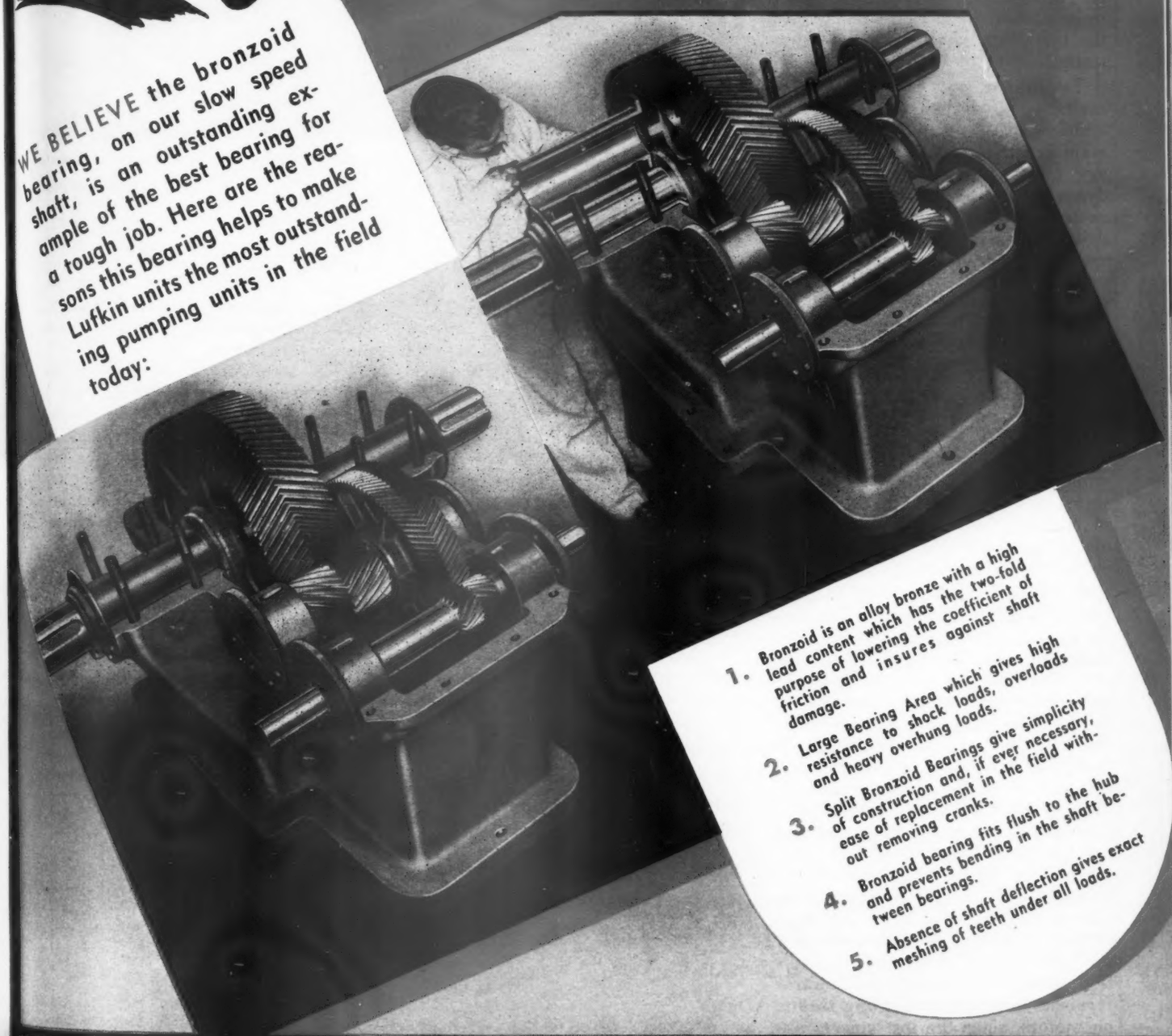
Amplidyne motor-units are used for excitation of main generator and rotary table generators. The use of amplidyne voltage control gives instantaneous response to driller's controls and provides a means of limiting torque on motors.

Two 500-hp slush pumps are driven by air-pressurized, direct-current motors through revolutionary "HY-VO" silent chain drives.



Lufkin USES ONLY THE BEST In BEARINGS

WE BELIEVE the bronzoid bearing, on our slow speed shaft, is an outstanding example of the best bearing for a tough job. Here are the reasons this bearing helps to make Lufkin units the most outstanding pumping units in the field today:



1. Bronzoid is an alloy bronze with a high lead content which has the two-fold purpose of lowering the coefficient of friction and insures against shaft damage.
2. Large Bearing Area which gives high resistance to shock loads, overloads and heavy overhung loads.
3. Split Bronzoid Bearings give simplicity of construction and, if ever necessary, ease of replacement in the field without removing cranks.
4. Bronzoid bearing fits flush to the hub and prevents bending in the shaft between bearings.
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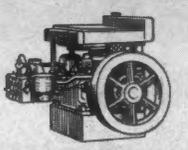
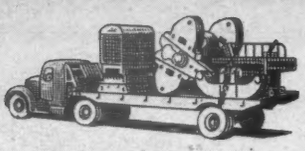
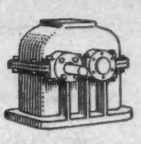


LUFKIN-COOPER-BESSEMER ENGINES



LUFKIN OIL FIELD AND INDUSTRIAL TRUCK TRAILERS



INDUSTRIAL SPEED REDUCERS AND INCREASERS

DIVISION LUFKIN FOUNDRY & MACHINE COMPANY INDUSTRIAL, MILL AND AUTOMOTIVE SUPPLIES

two pumps, and one blower and cable reel unit.

Main control equipment consisting of control and transfer switches, contractors, relays, amplidynes, alternator, and other electrical devices is in a separate skid-mounted unit. (See electrical distribution diagram.) The electrical distribution system is arranged to permit maximum operating versatility, and generator units may be paralleled to distribute the power in any desired combination between the two mud pumps and the drawworks motor.

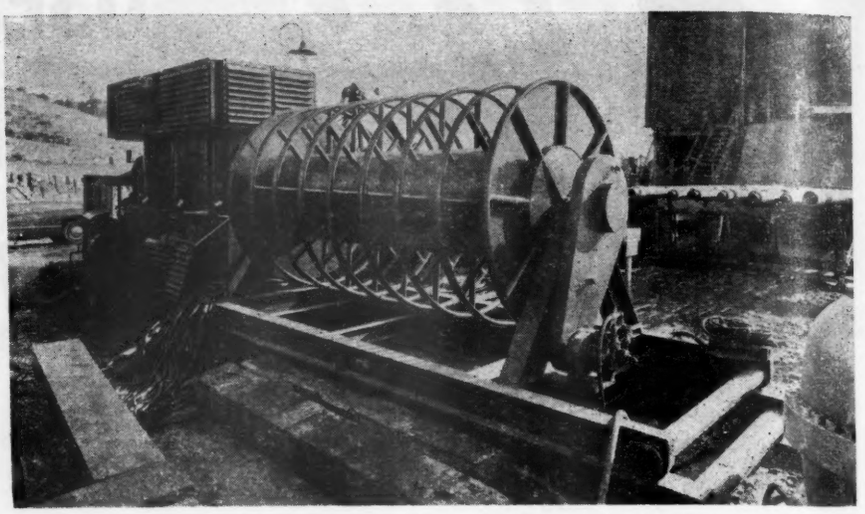
Two motor units are provided for excitation of the main 1200-kw generators (5-kw amplidyne for each main generator) and the 300-kw rotary table generators (2-kw amplidynes). The two amplidynes are connected by a flexible coupling and are driven by a 15-hp electric motor. The use of amplidyne current limit exciter control gives instantaneous response to the control system, and when the two main generators are paralleled, assures equal distribution of load.

The amplidyne is a direct current machine similar in many respects to a d-c exciter. It was developed by General Electric and gives a high speed amplified response to a very small d-c signal and thus, controls the output of the main generators very accurately.

The amplidyne is used in conjunction with a magnetic amplifier commonly called the amplistat. This latter has no moving parts and provides extremely accurate amplification of a very small d-c signal. It picks up the voltage drop across the commutating field of the generator and amplifies this sufficiently to control the amplidyne. The amplidyne in turn controls the output of the main generators driving the mud pump, rotary table and drawworks, synchronizing the driving motor with the driven equipment. This system allows the driller to control the output of the largest motors very accurately by the mere turning of a small potentiometer dial no larger than a radio dial. In addition, the use of amplidyne control furnishes a means of limiting torque on motors, since the instruments are preset to limit the power that the generator can deliver.

All electric motors have built-in electric heaters to prevent accumulation of moisture in motor windings when the rig is shut-down under high humidity conditions.

More than 3500 ft of 1000 MCM cable (approximately 2 in. in diameter) is used for power connections between generators, motors, and control points. This represents a total weight of cable of about 7 tons.



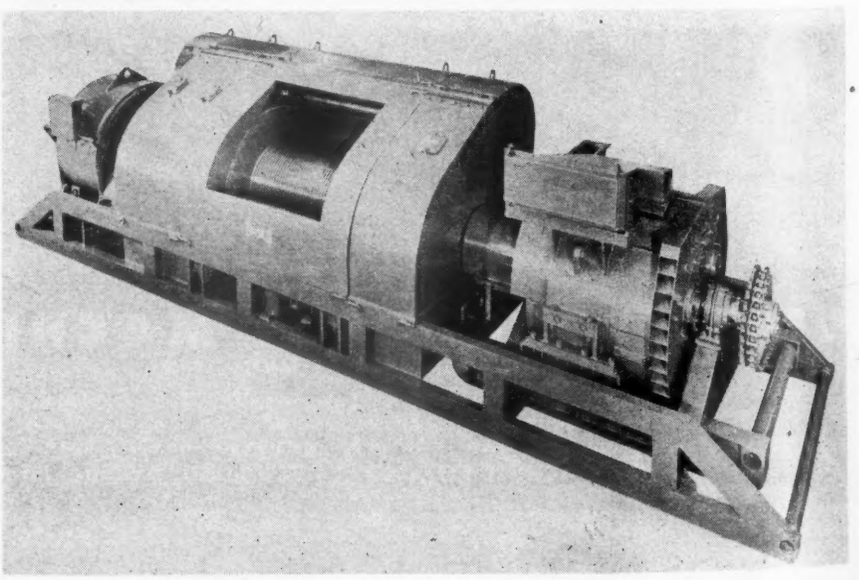
Ventilating blowers and cable reel skid-mounted unit. Reel transports electrical cables. Over seven tons of main power cable are employed.

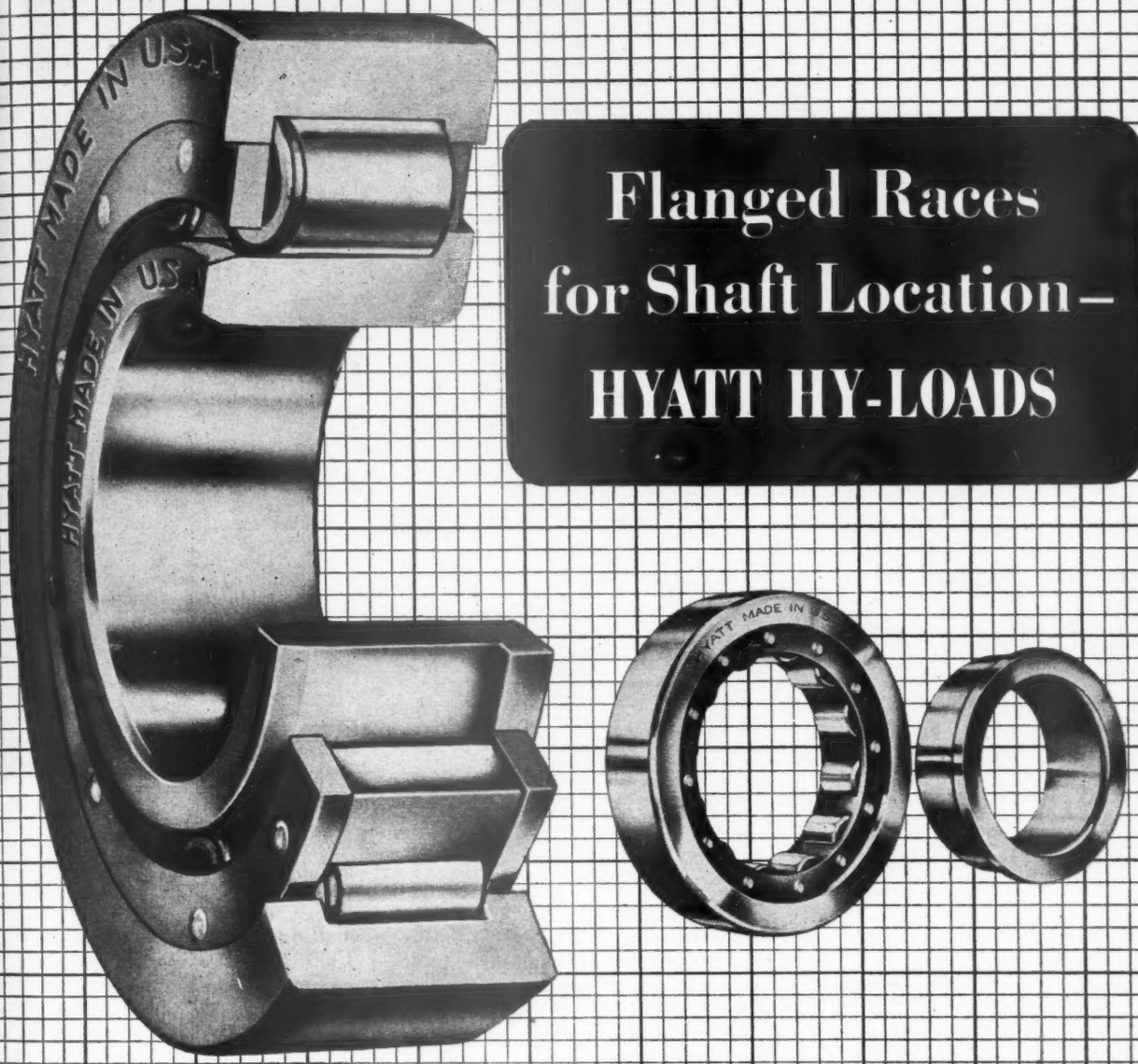
A 3-phase, 60-cycle, 440-volt 100 KCA alternator is provided for supplying power to rig auxiliaries, such as blower motors, shale shaker, brake water circulating, lighting, and rig heating.

Three axial flow blowers are used to cool all motors and to keep a constant supply of fresh, filtered air passing through all electrical units in which explosive gases might accumulate. The blowers are situated about 90 ft from the derrick and are so arranged that the air is picked up 7-8 ft above ground level. The filtered air passes through a large, canvas duct to the derrick substructure where feeder ducts take it to the drawworks motor, rotary table motor, mud pump motors, and the driller's console. Besides eliminating explosion hazards, this air keeps motors at safe operating temperatures.

The secondary power circuits are electrically interlocked through a time-delay relay so that the blowers must be started prior to the motors. This gives enough time for the motors and console to be purged of any gas that might have accumulated during a shut-down. The main control panel is also ventilated by means of this forced draft system in order to keep dust from collecting in the electric relays and other devices. The generator sets are cooled by a fan situated on the main generator of each. This fan sucks air through a filter

Drawworks is set at ground level under derrick floor and is driven by 1500 hp motor. Drawworks brakes are 100 per cent air-operated from driller's console. An emergency brake is part of the main braking system.





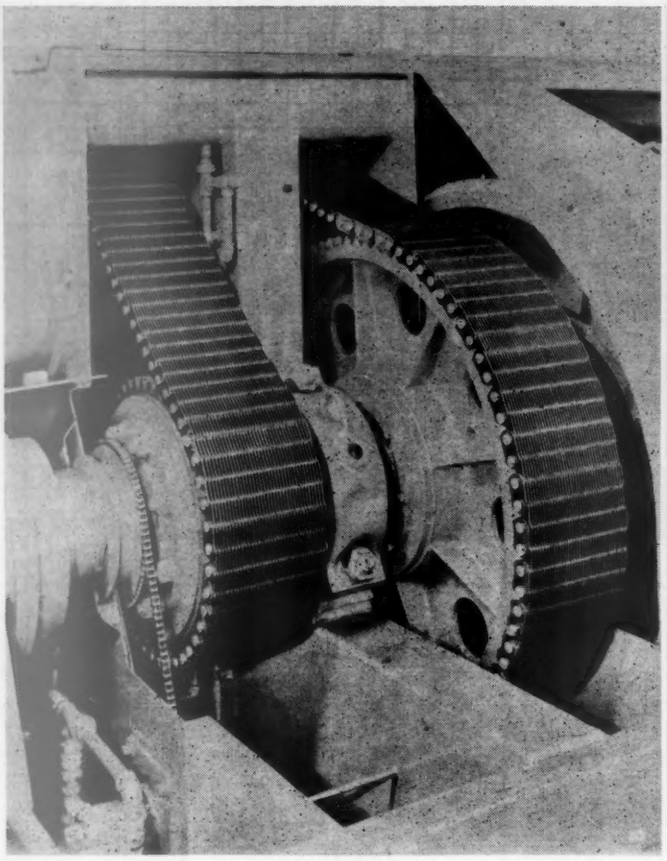
Flanged Races for Shaft Location– HYATT HY-LOADS

FLANGED RACES permit "R-WB" Type Hyatt Hy-Load Roller Bearings to locate shafts or gears or accommodate light or intermittent thrust in one direction. Used in pairs, they can locate shafts or accommodate thrust loads in both directions.

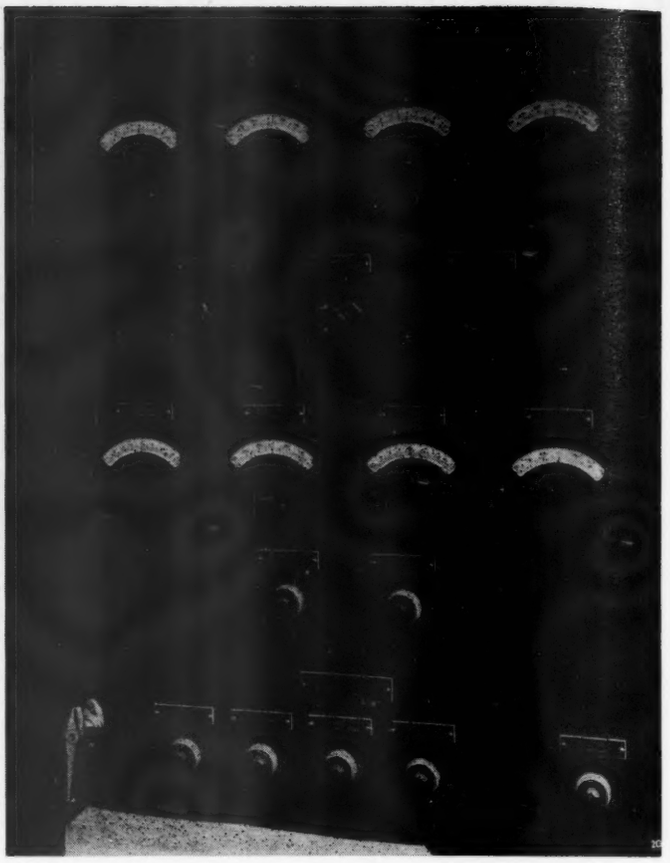
The ability to locate shafts and handle light thrust loads is an added feature of this Hy-Load bearing. Its primary advantage is its ability to carry high radial loads.

Hyatt Hy-Load Roller Bearings are adaptable for many bearing installations. There are ten different types, each made in many different sizes to fit almost every application need. Write for your copy of Hyatt catalog 547 for complete information about Hyatt Hy-Load Roller Bearings. Hyatt Bearings Division, General Motors Corporation, Harrison, N. J.

HYATT ROLLER BEARINGS



Revolutionary "HY-VO" chain drive used in drawworks provides maximum load capacity per unit of width.



Close-up of one of the many control panels showing control devices.

box and discharges it through the three generators.

Personnel and equipment are protected by many safety devices. Alarm signal lights at the driller's console indicate excessive current in any motor. A relay prevents engine overspeed due to electrical power pump-back in case the drawworks motor should inadvertently be connected when running pipe in the hole. It is operated by a tachometer mounted on the engine and operates a solenoid valve on the drawworks air brake. An alarm signal actuated by a tachometer on the drawworks motor indicates motor over speed. Also, the driller can kill all electric power beyond the load side of the main panel in the event of an emergency. Main control panel doors are equipped with electrical interlocks, which automatically deenergize the panel when the doors are opened.

The rotary machine and motor are mounted under the derrick floor on an independent substructure, and the rotary table is placed practically flush with the derrick floor to provide safe footing for the drilling crew. Between the motor and the rotary table is a universal-joint-type shaft drive, which permits the table to be shifted 2½ in. in any direction. Having an independent substructure for the rotary table facilitates installation of the blow-out preventers since the table can be lifted out and the preventers can be installed from the derrick floor level. Drill pipe setback loads are transferred directly to the ground by means of a special substructure which is also independent of the derrick floor.

The two 750-rpm, 12-cylinder diesel engines were previously used as the main propulsion engines in a Navy LST. Originally rated at 900 hp for continuous service, these engines were completely reconditioned and provided with suitable cooling for the increased horsepower required in this drilling rig. They are now rated at 1200 hp for intermittent duty. A unique cooling system was developed for the oil field application of these engines. A fan is mounted at the top of the dual radiator unit and is driven through a right angle gear box from the engine. One radiator unit is employed for engine cooling, while the other is used for water-circulating to the lubricating oil cooler.

Adjacent to the air receiver on the generator end of the engine-generator unit sub-base is a small auxiliary fuel feed tank that is gravity fed from nearby storage. Fuel is maintained at a constant level in the small tank by means of a float-type valve in the inlet line, and is continuously circulated between it and the engine to maintain constant fuel temperature. Because of the relatively low engine speed, a low cost industrial type diesel fuel replaces the more expensive fuel generally used for oil field service. This should effect substantial savings in fuel costs. Standard's industrial lubricant division, working in collaboration with operating personnel, is using the engines on tests for determining the performance characteristics of certain new improved heavy duty lubricants with which they are now experimenting. * * *

Seismic Exploration

The Institute of Inventive Research of San Antonio has been granted full protection by the U. S. Patent Office on its newly-developed Poulter Method for seismic exploration, A. J. Baxter, Institute manager, disclosed. Designed primarily to obtain an improved quality of seismic records by the elimination of multiple reflections, the Poulter Method is said to reduce the amount of field equipment by avoiding the drilling of shot holes. The air shooting method has been tested extensively and is credited by the Institute with location of two new oil fields.

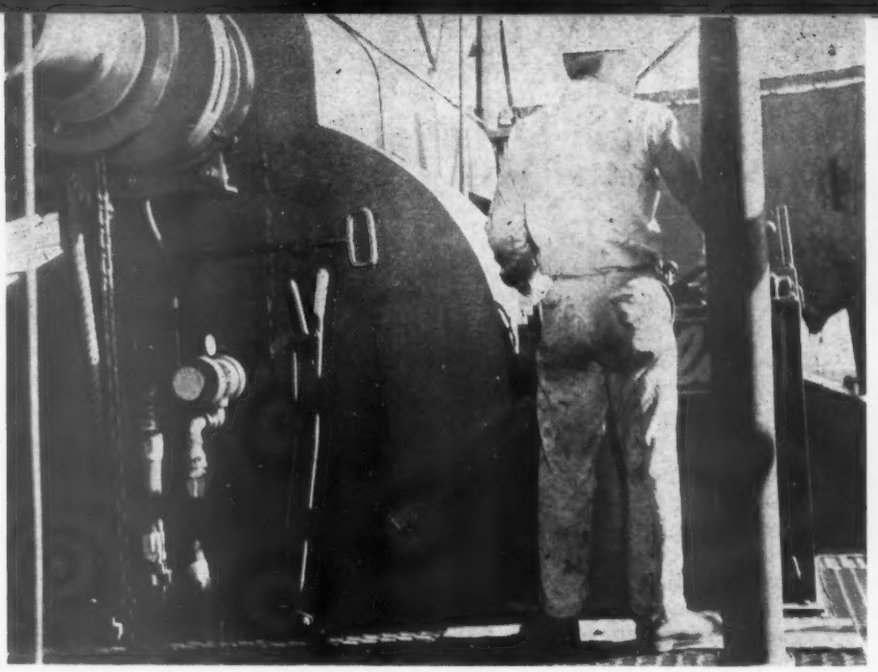
available. The operator hesitated to purchase a heavy steam rig, because he anticipated moving the rig to other locations where low cost fuel and an ample supply of soft water would not be available. The "Steamair" rig thus enables him to continue drilling the deep test with his old equipment and to convert it over to a power rig when it is moved to another well.

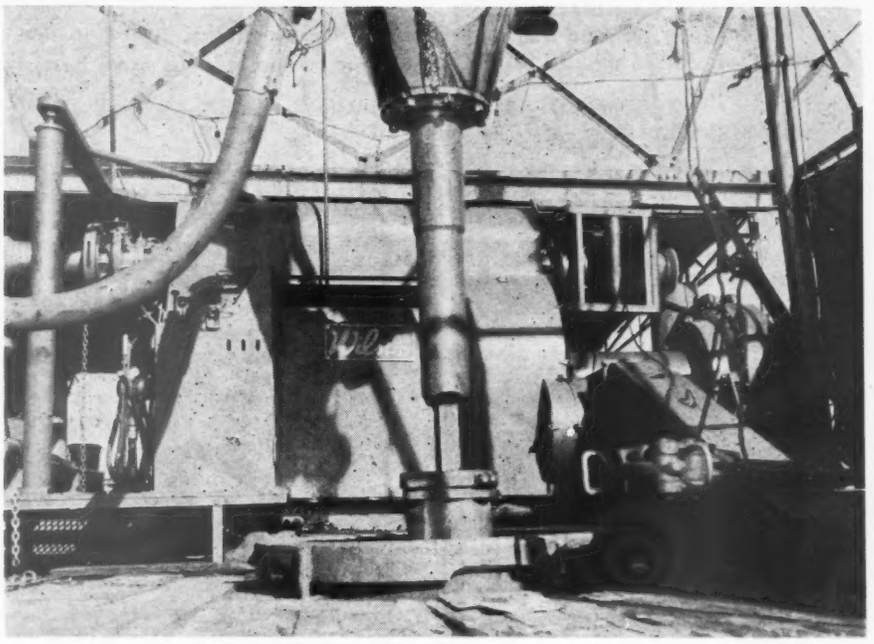
The conversion to a power rig can be made simply by the addition of a compound transmission and multi-cylinder, internal combustion engines. The steam mud pumps, of course, will have to be replaced with power pumps.

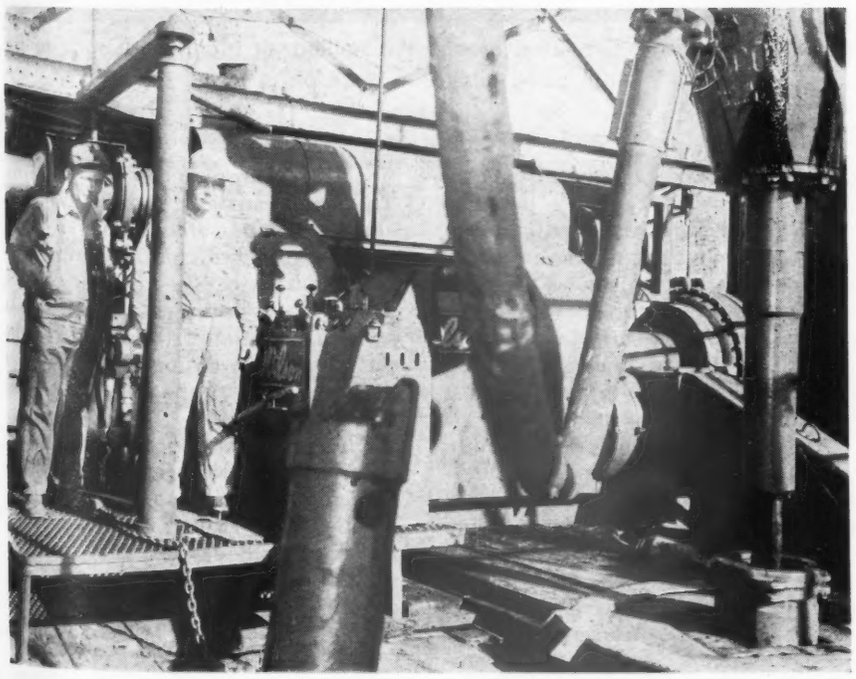
Operating Conditions

The four 125-hp boilers are operated with from 300 to 350 psig pressure. An 18 by 8 by 20-in. slush pump and a 14 by 7¼ by 18-in. slush pump are used to circulate the drilling mud. The standpipe pressure was about 1650 psig at the time the photographs were taken. A string of 3½-in. drill pipe with five 5-in. drill collars and a 6⅛-in. rock bit was being used. The rotary table was being driven by a 120-in. double chain with 2-in. pitch from the drawworks. The rotary can be operated at two different speeds without changing the speed of the 12 by 12-in. steam engine.

The drawworks can be operated at four different speeds without changing the speed of the steam engine: Low - low, low - high, high - low, and high-high. These designations refer to the two speeds available on the drum and the two speeds available on the drawworks transmission. Speed changes may be made by manipula-







The driller, top, manipulates the toggle switch air-control valves that operate the rig from a central control box.

Center, the rotary was turning about 40 rpm as preparations were being made to pull-up and add another joint of drill pipe.

The toggle switches, left, of the control panel enable the driller to select four hoisting speeds and two rotary speeds without changing the speed of the steam engine.

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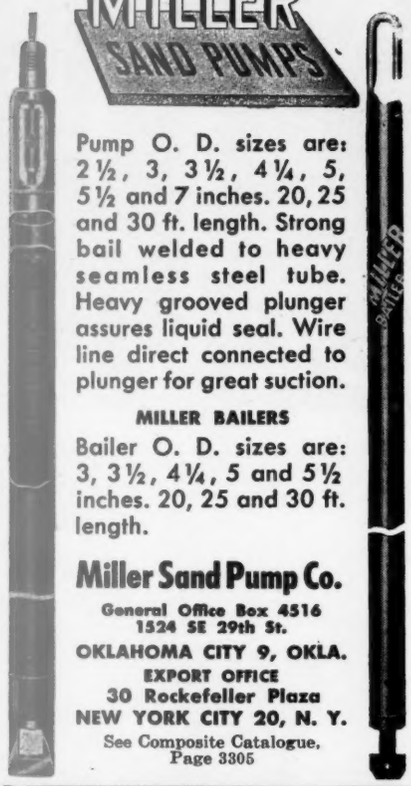
MILLER SAND PUMPS



Pump O. D. sizes are: 2½, 3, 3½, 4¼, 5, 5½ and 7 inches. 20, 25 and 30 ft. length. Strong bail welded to heavy seamless steel tube. Heavy grooved plunger assures liquid seal. Wire line direct connected to plunger for great suction.

MILLER BAILERS

Bailer O. D. sizes are: 3, 3½, 4¼, 5 and 5½ inches. 20, 25 and 30 ft. length.

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See Composite Catalogue, Page 3305

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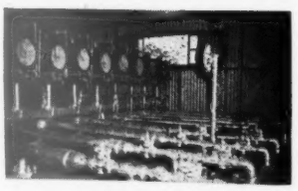

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SURVEYS
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SUPERVISION

PETROLEUM ENGINEERS
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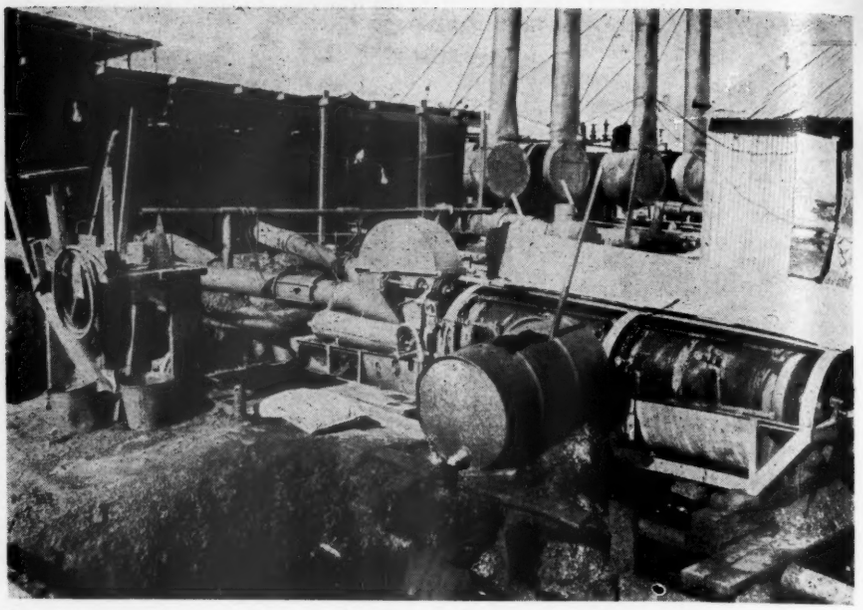
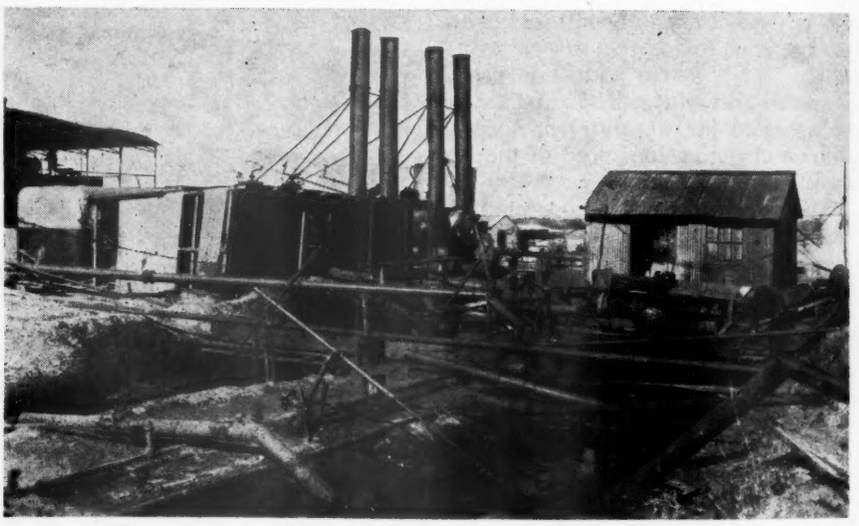


Top, chemicals are added to the mud stream from the drum after the shale and cuttings have been removed by the rotary-type shaker.



Center, drilling mud circulates through the settling pit (right) and back to the slush pump intakes through pit at left.

tion of the toggle switches on the control panel at the driller's position, which operate air-controlled clutches, or simply by changing the speed of the steam engine. This gives the driller a wide selection of speeds for operating the rotary table and drawworks. Ten 1⅛-in. lines were strung through the heavy 5-sheave traveling block being used.

A quebracho and caustic mud weighing about 10 lb per gal and having about 3 to 5 cc water loss was being used. Returns were being checked constantly by a mud-logging laboratory truck.

A two-stage air compressor driven off the drawworks transmission supplied the compressed air for operation of the air-clutches and controls. The compressed air storage tank was equipped with safety valves to prevent the pressure from exceeding 100 psig, and the clutches are set to kick out, if the pressure should fall below 60 psig. This latter feature is for the purpose of preventing excessive wear due to clutch slippage at low pressures.

The rig is equipped with a 46-in. Hydromatic[2] brake and a dual-controlled-torque cathead. It also has a reverse lever, so that the engine may be reversed, if desired. It is unnecessary to use the lever, however, to disengage the clutches. ★ ★ ★

[2]Parkersburg Rig and Reel Company, Parkersburg, West Virginia.

This

is the tool that is revolutionizing drill string protection on today's wells!

The SHAFFER-WAGGENER BUMPER SAFETY JOINT

This is the *only* tool of its kind—the ONE tool that combines BOTH *Jarring* and *Releasing* action—each under the full control of the operator—for protecting modern drill strings, whether deep or shallow. And not only does it combine in *one* tool the protection usually requiring several tools, but it also provides unique operating advantages *found in no other single tool or combination of tools!*

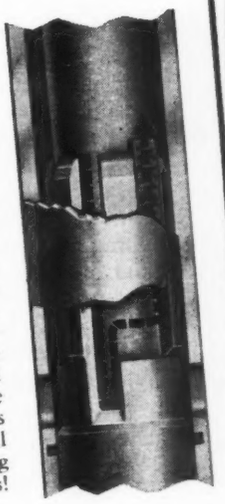
Briefly, here's how it operates . . .

TO USE AS A BUMPER SUB

you need only slack the weight of approximately 2,000 feet of drill string upon the Bumper Safety Joint. This weight actuates a positive tripping mechanism which trips *automatically*, allowing the tool to strike a sharp downward blow. Raising the pipe then *automatically* resets the tool for another blow. Blows can be struck repeatedly and continuously by simply raising and lowering the drill string.

TO USE AS A SAFETY JOINT

for quick release from stuck drill collars in the event they cannot be loosened, you simply slack the tripping weight of the string on the Bumper Safety Joint and apply left torque as the string is slowly raised. The slight reverse torque rotates the drive keys into an unlocking slot similar to a "J" tool, so that, by simply continuing to raise the string, complete release from the lower portion of the drill string is effected. Further, the mandrel remaining in the hole is smaller in diameter than the drill collars, thus greatly facilitating fishing operations in tight holes!



TYPICAL SERVICE RECORDS

On job after job—from the shallowest wells right down to world's record depth—the Shaffer-Waggener Bumper Safety Joint is bringing new safety, new efficiency to modern drilling operations. Here are a few typical accomplishments . . .

- The Shaffer-Waggener Bumper Safety Joint has been used successfully in extreme directionally-drilled wells where a slant of 60° was maintained.
- The Shaffer-Waggener Bumper Safety Joint has been released and reconnected from a 30° angle at a depth of 8,500 ft.
- At 16,883 feet in the world's deepest well the Shaffer-Waggener Bumper Safety Joint proved invaluable in simplifying a recovery operation. A Bumper Safety Joint was being used between the drill collars and drill pipe when the string parted going into the hole, dropping over 2,400 feet of pipe and drill collars 5,000 feet to the bottom of the well at 16,883 feet. The top of the fish was gripped with a socket and the Bumper Safety Joint released, immediately recovering 2,100 feet of drill pipe. The upper part of the Bumper Safety Joint was then run back into the hole below a set of jars, reconnected to the lower half of the Bumper Safety Joint and—after jarring—the drill collars were completely recovered, leaving the hole clean.

***Note:** For maximum protection many operators are using the Bumper Safety Joint above wash-over strings to facilitate recovery should the string become stuck.*

Whether used as a Bumper Sub or as a Safety Joint, the Shaffer-Waggener Bumper Safety Joint provides unique advantages found in no other tool—advantages too numerous to outline here but which are described in detail in a descriptive bulletin which will gladly be sent you on request. Send today for your free copy of this informative eight page bulletin!

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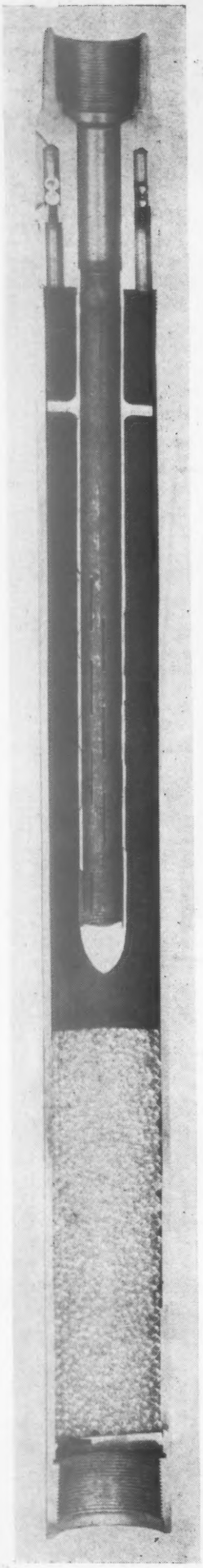

Sand and Gas Control in Pumping Wells

NORMAN C. WELLS

THE pump-powered filter is one of many devices developed to reduce sand wear and clogging of bottom-hole pumps. This type of tool (see Fig. 1)*, run on the tubing below the pump shoe, employs a moving pack of 0.300-in. diam glass agates as its filtering element. These agates are made of an especially hard and tough glass.

Movement of the pack is caused by the well fluid as it is drawn through the filter by the pump. The amount of sand or other solids that can pass through to the pump on any one stroke is dependent upon the fluid's speed and volume and the area of the voids between the constantly shifting agates. Angled perforations at the bottom of the filter barrel give the fluid and the agates a swirling motion that tends to keep the sand in longer grinding contact and in better suspension in the fluid for proper flow control to the pump. Such filters are not designed to keep out sand, but to produce it with the fluid at a constant rate, so that the pump can handle it with a minimum of wear and clogging. Also, sharp-grained sand particles are ground against each other by the action of the agates and become somewhat rounded and less abrasive by the time they reach the pump.

Though pump-powered filters are helpful in correcting a number of troublesome sand conditions, there are several types of problem wells in which they are not effective. They will not correct a serious heaving or bridging condition or operate satisfactorily in heavy mud-cut fluid. They are not designed to take the place of gravel packs, pre-packed liners, or other similar sand-restricting screens. They have proved very effective, however, when used in conjunction with screens that have gages large enough to permit free oil flow with troublesome quantities of sand. The filters are helpful in handling fine flour sand that cannot be bailed, yet is present in sufficient quantities to stick or wear out pumps prematurely.

Pump-powered filters are credited with correcting certain types of gas troubles, particularly those where troublesome sand conditions are also present. Filters of this type are now designed as gas anchors and are being used in many "gassy" wells of both high and low gravity crude oil. The motion of the agates tends to break down the "skin" tension of gas bubbles, using friction to break gas free of the fluid. This movement through the agates rapidly merges little bubbles into larger ones that separate from the oil more readily.

*Manufactured by Agate Corporation, Los Angeles, California.

FIG. 1. Cutaway view of glass agate filter.

EXCLUSIVE

Installation Problems

Proper installation of powered filters is not always the simple job of attaching the unit to the pump shoe. In some instances, pump sizes have had to be changed, strokes per minute reduced, and stroke lengths adjusted to obtain maximum effectiveness on longer stroke pumps. In many low capacity producing wells, the extra corrective work is not justified. In others the investment has been returned in a matter of months. The filters have made profitable producers of wells that have stood idle for years because of servicing costs. One filter unit is credited with keeping a well on the pump for 15 months without a pulling job after the well had been shut down for 10 years because of excessive pulling frequency.

Installation of the filter in wells where sand is coming in at a rapid rate, or where bailing has failed to clean out all the sand, sometimes necessitates lowering the tubing, a stand or two at a time, after the well has been put back on the pump. In general, it has been found more satisfactory to pump lower with a powered filter, because agitation of the incoming sand helps prevent a rapid accumulation at the bottom of the hole and tends to maintain constant removal of the sand with the fluid. Steadier production tends to reduce down time

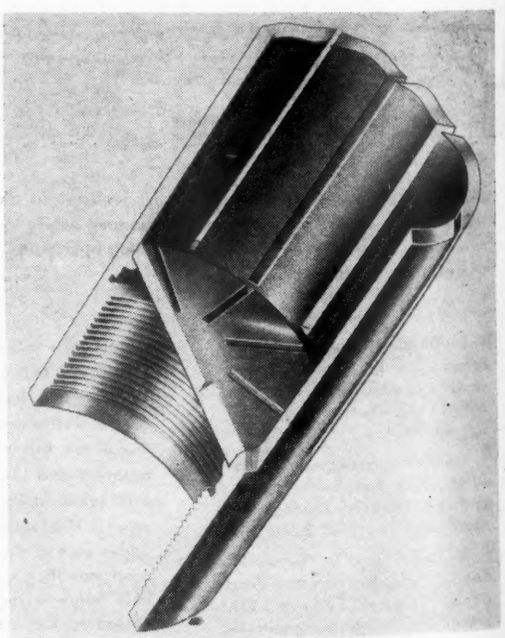

FIG. 2. Angled perforations in side wall and lower baffle give directional spin to fluid and agates.

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from intermittent locking and clogging and has resulted in a pumping down of wells that formerly maintained relatively high fluid levels. Skimming of wells after installation of these filters has been found unnecessary and undesirable in most instances.

Unsatisfactory performance sometimes has been traced to installation of filters below anchors or lengths of tubing. Where sand is a problem and the filters are placed too far below the pump, part of the drifting, filtering action is lost, and the heavier sand tends to settle back in clogging amounts. Experience has shown that powered filters should be installed directly below the pump for maximum effectiveness, if sand is a factor.

Larger Filters Used

Decreases in daily production rates have resulted from some installations of filters. In some cases, the cause has been use of units of insufficient capacity. Installation of larger filters has corrected the trouble. In some wells, where relatively large tolerance pumps have been used to handle sand, the filters, regardless of size, have restricted production. The only justification for their continued use has been their ability to reduce pulling frequencies and down time to a point where net production has shown an increase.

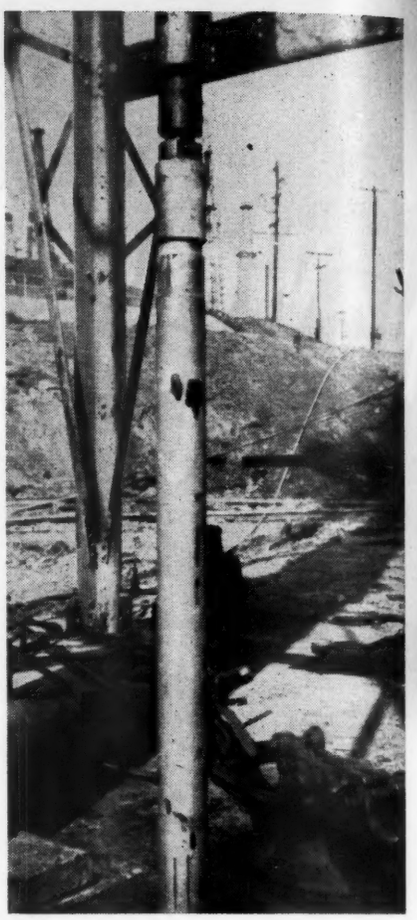

FIG. 3. Filter attached directly to pump shoe is ready to be run into well.

Low gravity, low temperature wells with troublesome sand conditions were not helped by powered filters until larger sized agates were developed. The .300-in. spheres were found to be too light and too friction-bound to operate effectively in most wells of 12 deg or lower gravity. Filters repacked with larger agates have helped considerably to break gas out of heavier crudes and to keep sand moving more evenly and steadily through the pump.

Standard models of the unit have handled production containing more than 30 per cent sand. In many cases they have saved numerous "wet" jobs and, also, "stripping" jobs.

A number of improvements have been made in the filter since its first application to pumping wells. The agates are made of tougher glass than the first ones that were used and consequently should last much longer. Also, the design has been changed somewhat so as to improve both the gas and sand handling capacity. ★★

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"Speed with control has been built into Foster Catheads for the 26 years we have been specializing in their manufacture. The driller operates Foster Catheads from his regular position, and there's no time lost waiting for the shaft to slow down because powerful friction clutches engage with the cathead shaft running at high speed." Sold thru supply stores everywhere.

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ECONOMICAL . . . will spin and tong with forked line.
DEPENDABLE . . . heavy bearings, well lubricated . . . records of years of operation without repairs.
SAFETY . . . eliminates hand-wrapping of spinning line.

Foster Master, Type B, Breakout Cathead

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ECONOMICAL . . . no metal-to-metal impacts . . . no complicated brake necessary.
DEPENDABLE . . . powerful friction clutch . . . roller bearings.
FLEXIBLE . . . recommended for either air or manual controls.

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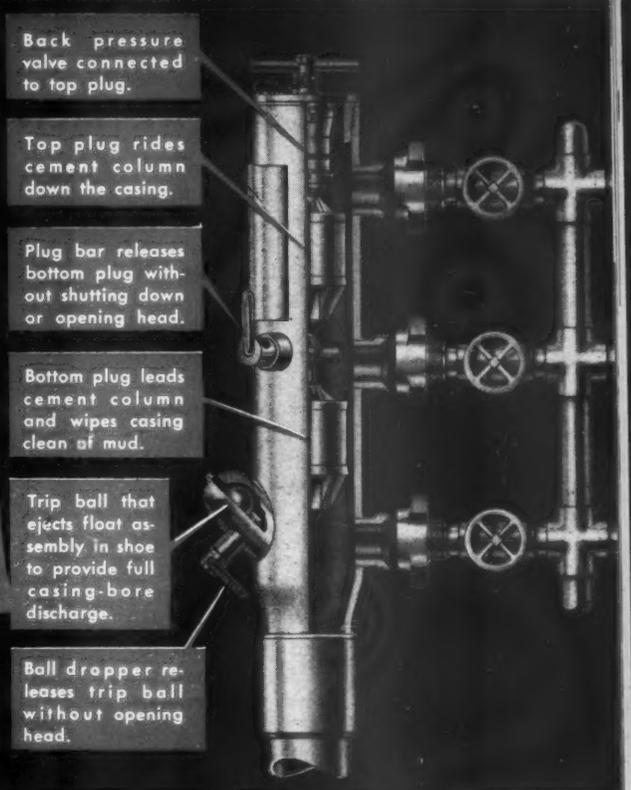
From HEAD to SHOE


Back pressure valve connected to top plug.
Top plug rides cement column down the casing.
Plug bar releases bottom plug without shutting down or opening head.
Bottom plug leads cement column and wipes casing clean of mud.
Trip ball that ejects float assembly in shoe to provide full casing-bore discharge.
Ball dropper releases trip ball without opening head.

RECTOR FULBORE CEMENTING METHOD

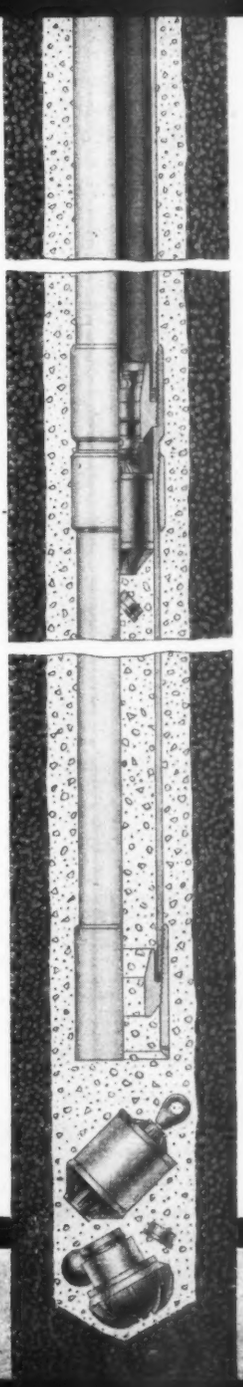
prevents contamination of cement

Every operator knows that voids caused by air pockets in the cementing string or soft spots due to contamination are the perfect set-up for future trouble. Prevention of these weaknesses is the basis of "Fulbore" cementing superiority . . . the assurance of a master cementing job, everytime.

The "Fulbore" multiple inlet head provides a closed circuit from beginning to end of cementing operations. The two plugs, made up in the head before it is connected to the casing string, are released mechanically without downtime. the plugs completely and effectively segregate the cement from the time it enters the head until discharged at the shoe. There is no possibility of contamination or the formation of air pockets.

Extreme simplicity is another advantage of "Fulbore" cementing. There are no discs to break . . . no small orifices through which the cement must be pumped. Traveling ahead of the cement, the bottom plug is pumped out of the casing through the float shoe from which the float assembly has been ejected after cementing string has been floated into position. This provides full casing discharge capacity . . . reduces the load on the pumps . . . permits greater volume to be circulated with same pump discharge pressure . . . results in higher velocity in space between casing and bottom of hole.

Every phase of "Fulbore" cementing is planned to make every job a master cementing job. Ask your Rector Representative or authorized supply store for full information about "Fulbore" Cementing and equipment.



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UNITIZED COMPARTMENT TANKS

J. C. ALBRIGHT

A UNITIZED compartment tank designed by Camay Drilling Company of Long Beach, California, enables the supplier of drilling rig lubricants and solvents to make bulk deliveries covering the various quantities needed. The skid mounted tank is moved along with the rig, thus preventing loss of oil often left behind in drums. Another advantage in favor of the compartment oil tanks is that workers need not lift heavy drums from the ground and place them upon rocks.

Camay uses smooth, flat tank steel for the walls and partitions of the bulk oil tanks. The partially completed tank is an open top box into which the partition walls are inserted and welded at all seams. The end panels of the tank are about 18-in. longer than the depth of the tank, serving to enclose the lower part of the unit and act as supporting members.

Measuring cans and other materials may be in the open compartment below the tank. The entire tank is bound at all square corners with angle iron strips that are tack-welded for unit strength. U-bolt lugs are welded at each of the four top corners of the tank for lifting it with a truck boom or crane.

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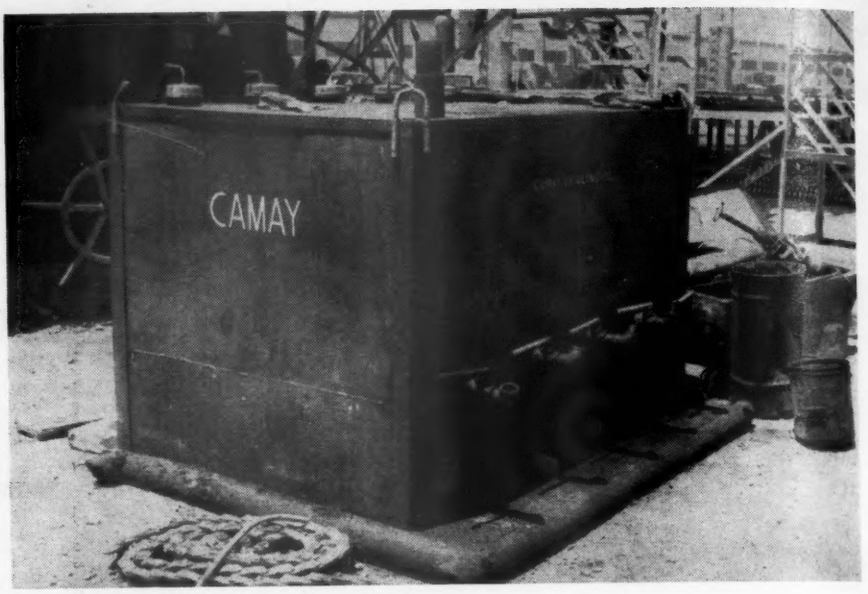

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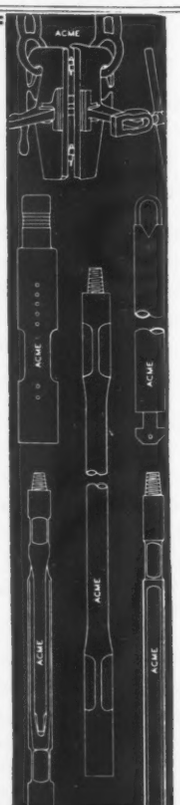

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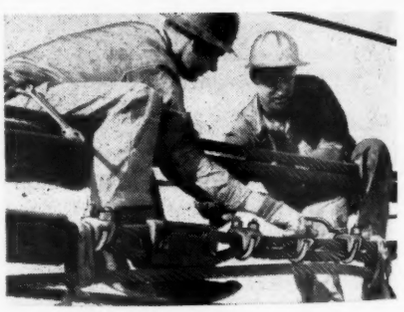

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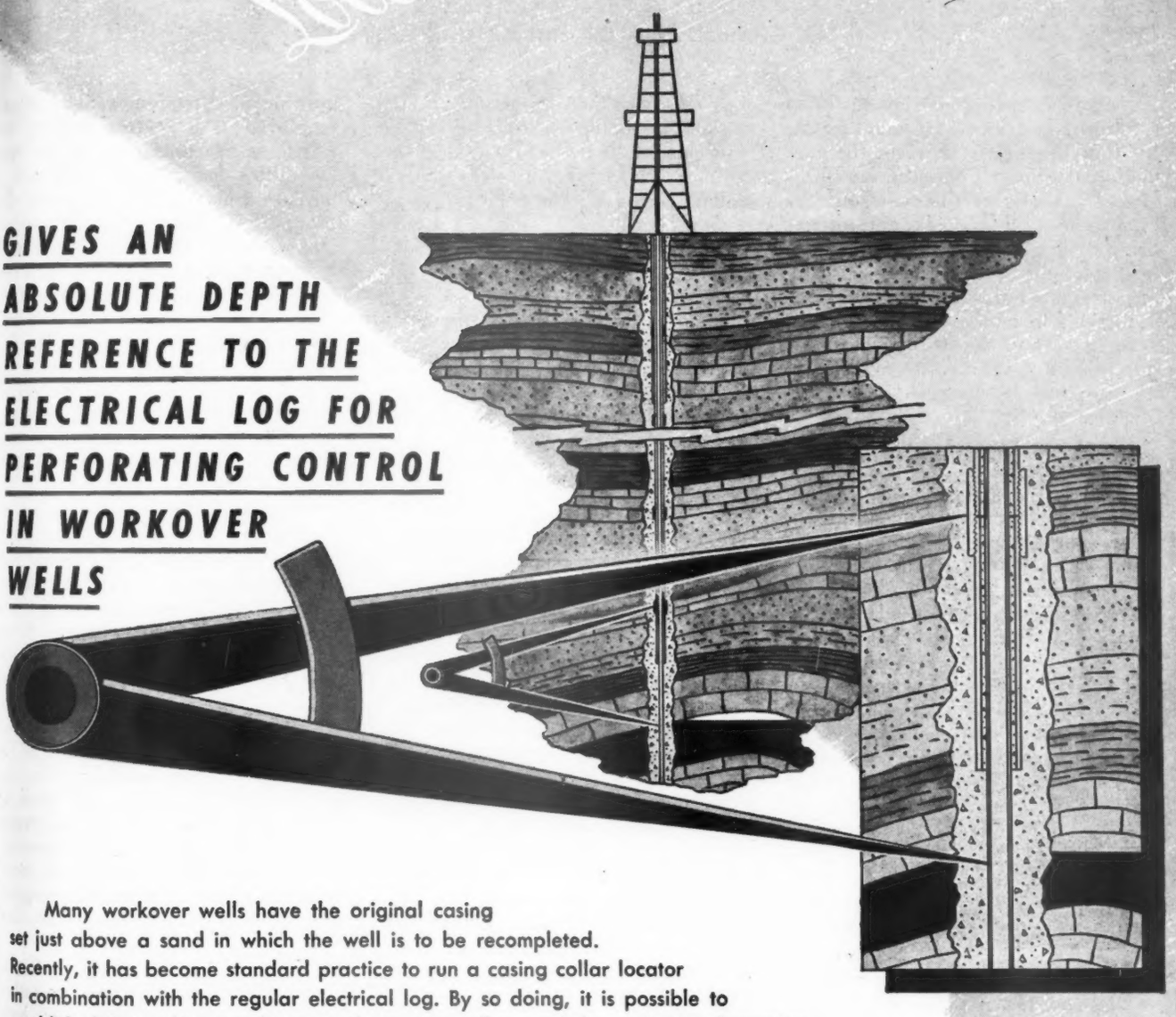

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Straight-Hole Drilling in Crooked-Hole Country

G. C. MacDONALD† and ARTHUR LUBINSKI‡

At its 1950 Spring meeting, the Mid-Continent District API Committee on Drilling Practice authorized the formation of a Study Committee on Bore-Hole Drift. During the year since its organization, this study committee has sought both theoretical and practical solutions to the problem of drilling straight holes in crooked-hole country. The purpose of this report is to present to the drilling industry information developed to date which the committee believes is of immediate practical use.

A satisfactory definition of a crooked hole has not yet been developed because of the inter-relationship of the terms "vertical" and "straight". It is reasonably apparent that angle alone will not suffice for definitive purposes because sharp dog legs from side to side within the angle limitations could produce an objectionable hole. Rate of change added to angle would assist in defining a dog-legged hole; but a hole following a tight spiral at a low, uniform angle could be equally objectionable mechanically, yet would have no excessive vertical angle or rate of change. The consideration of direction seems almost inescapable at this time.

Oversized drill collars have had limited use in the Mid-Continent area and have contributed materially to straight-hole drilling. Bit weights which will cause drill-collar strings to buckle, and hence place other than vertical forces on the bit, have been mathematically developed. It was found that those critical weights, above which drill-collar buckling could be expected, corresponded exactly with the results of field experience in determining the maximum bit weight that could be carried with various drill-collar sizes without causing excessive hole deviation to develop. The mathematical investigation was carried further to establish the point at which various sizes of drill collars would buckle when excess bit weight was applied; and it was discovered that reamers, rollers, or stabilizers used in the past were seldom, if ever, properly placed in the string. Such proper position is brought out herein.

An early attempt was made to define a crooked hole, which was not too successful. An understandable confusion exists in the customary use of the terms "straight," "crooked," and "vertical" when applied to a drilled hole. A 3-deg hole might be rifle-bore straight, if the deviation were all in one direction, but obviously far from vertical. Such a straight, but non-vertical, hole would present little drilling or producing problem. A 2-deg hole could be more crooked if it swung sharply from 2-deg in one direction to 2-deg in the opposite direction several times throughout its depth. Although such a hole might be classed as vertical because the bottom of the hole would be close to a point directly beneath the surface location, it might have sharp dog legs up to 4 deg at several places and develop relatively serious drilling and producing problems. It is apparent that angle alone is inadequate to a definition of a crooked hole; the factor of rate of change in angle must also be considered.

A 2-deg hole following a tight spiral would be vertical, but far from straight; and if it held steadily to 2-deg, there would be no objectionable rate of change in angle, yet the spiral hole might develop serious key-seating difficulties, drill-pipe wear or intermediate casing, etc. To guard against the development of this type of hole, the consideration of direction must be added to that of angle and rate of change. This complicates the situation because, while angle and rate of change may be determined from the customarily employed slope-testing devices, an instrument for the recording of direction is not normally employed as a routine drilling tool. For these practical reasons, the study committee has not yet been able to develop a universally acceptable definition of a crooked hole. This subject is high on the agenda of future work.

The second subject requiring a clarification of thinking was that of the scope of the field of straight-hole drilling in crooked-hole country. The field has two provinces:

1. The maintenance of an acceptably straight hole.
2. The straightening of a hole which has exceeded the predetermined limits.

Obviously, the attainment of the first objective requires the prolongation of the axis of the existing hole without change, while the attainment of the second requires a change. The solution of the two problems is entirely different; and unless the distinction is clearly set forth, confusion results. Unfortunately, one very common field drilling practice is to drill as rapidly as possible as long as the angle of deviation remains below the permissible maximum, and then to hold up on the weight in an attempt to straighten an already excessively crooked hole. Most of the effort, therefore, has been in the second category, viz., that of straightening a crooked hole.

Before a revision of this policy is acceptable, there must be some rather definite indication that success, both mechanical and economical, will attend a proposal to drill a straight hole by the employment of techniques and equipment intended for that purpose. The study committee endeavored to survey the drilling field in order to determine what is being done, how it is done, and what success is being made. This report is intended to disseminate such information as is now available and pertinent.

One drilling procedure employed in crooked-hole country is that of drilling at the maximum possible rate of penetration to a point a few hundred

*Progress reports of the Mid-Continent District Study Committee on Bore-Hole Drift of the API Committee on Drilling Practice, represented at the Spring Meeting, API Division of Production, Amarillo, Texas, March 21-23, 1951.

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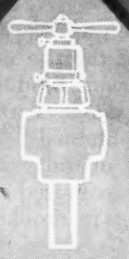

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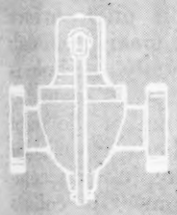

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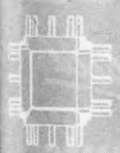

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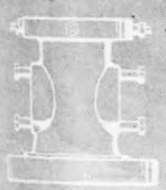

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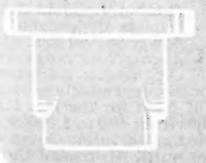

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feet above the objective horizon without regard for hole deviation. At that point, a directional survey is run; and, based on the results of that survey, directional whipstocks are employed to permit placement of the bottom of the hole in the objective horizon within a target area of prescribed dimensions under the surface location. The decision to employ this drilling technique should be based entirely on economics. Sufficient increase in penetration rate in the upper portion of the hole must be realized to compensate for the expense of the directional surveys and directional drilling of the last few hundred feet of hole. Since this procedure has been employed, economic justification has obviously existed in certain specific instances.

A review of the conditions influencing bore-hole drift brought forth a conclusion that formational conditions (hardness, thickness, dip, etc.) were the controlling factors. The mechanical devices and techniques employed to successfully penetrate these beds were those required by the beds themselves. In general, a hole drilled into a hard formation tends to drift up-structure while a hole drilled into a soft formation tends to skid down-structure or along the contour. A straight-hole drilling program should be designed to resist that natural bit-drifting tendency. There exists an understandable reluctance to accept the added expense of straight-hole drilling before the hole has actually gone crooked, at which time it is too late to attempt to employ straight-hole drilling techniques; the need then is for hole straightening operations. Some degree of financial stability, self assurance, and hard-headed obstinance would be indicated for any individual embarking upon a straight-hole drilling program while the hole is still straight. Before such a fortuitous combination of personal attributes could be attracted, there would have to exist some rather definite program which had a reasonable chance of producing the desired results. The objective may be very simply stated: the drilling of a hole meeting deviation specifications at a lesser expense.

Several procedures have been considered to date for straight-hole drilling, some in operation and one proposed. One practice in operation is the use of oversized drill collars. An oversized drill collar has been defined as one with an outside diameter greater than that which can be washed over in the hole in which it is being used. An 8-in. drill collar would, therefore, be oversized in a 9-in. hole but not in a 17¼-in. hole. Consideration of drilled hole size is inescapable in a discussion of oversized drill collars. Holes 8¾-in. and 9-in. are so common in the Mid-Continent area that discussion may be profitably confined to those two sizes; and, in addition, the two terms considered synonymous. Hereinafter the use of the term 9-in. should be considered as connoting both 8¾ and 9-in. Until recently any drill collar larger than 6¼-in. was considered oversize in a 9-in. hole; however, special overshots and wash-over strings are now available which can recover 6¾-in. collars in holes as small as 8⅝-in. Taps may be employed to fish oversized collars; but the opinion has been advanced that one fundamental concept in the use of oversized collars is that collar fishing jobs are eliminated, largely because they have so little possibility of success. In other than extremely hard formations, small holes have been drilled along side stuck collars, and the collars recovered after jarring.

What then are the hazards and advantages of the use of oversized collars; how long and how frequently have they been used; and what results have been obtained? At least two Mid-Continent drilling contractors have been using oversized collars in a routine manner in crooked-hole country for over two years. One used three 8-in. collars below six 6¾-in. collars, and the other uses six 7¾-in. collars in 9-in. holes. Both report no collar fishing jobs to date.

The contractor using six 7¾-in OD collars drills a 9⅞-in. pilot surface hole with the collars, making enough hole to dull a bit. Usually, the hole is reamed and surface pipe set some distance above the bottom of the pilot hole. As a result, there is sufficient hole below the surface pipe to accommodate the six 7¾-in. OD collars when the plug is drilled; and the surface pipe is, therefore, protected from drill collar whipping. Normal drilling conditions are 100 table revolutions per minute with 14,000 lb bit weight

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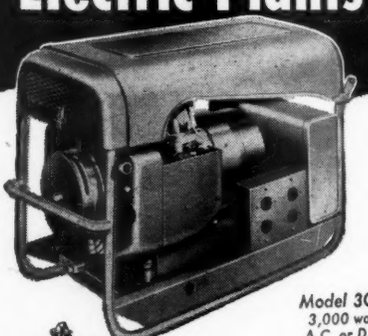

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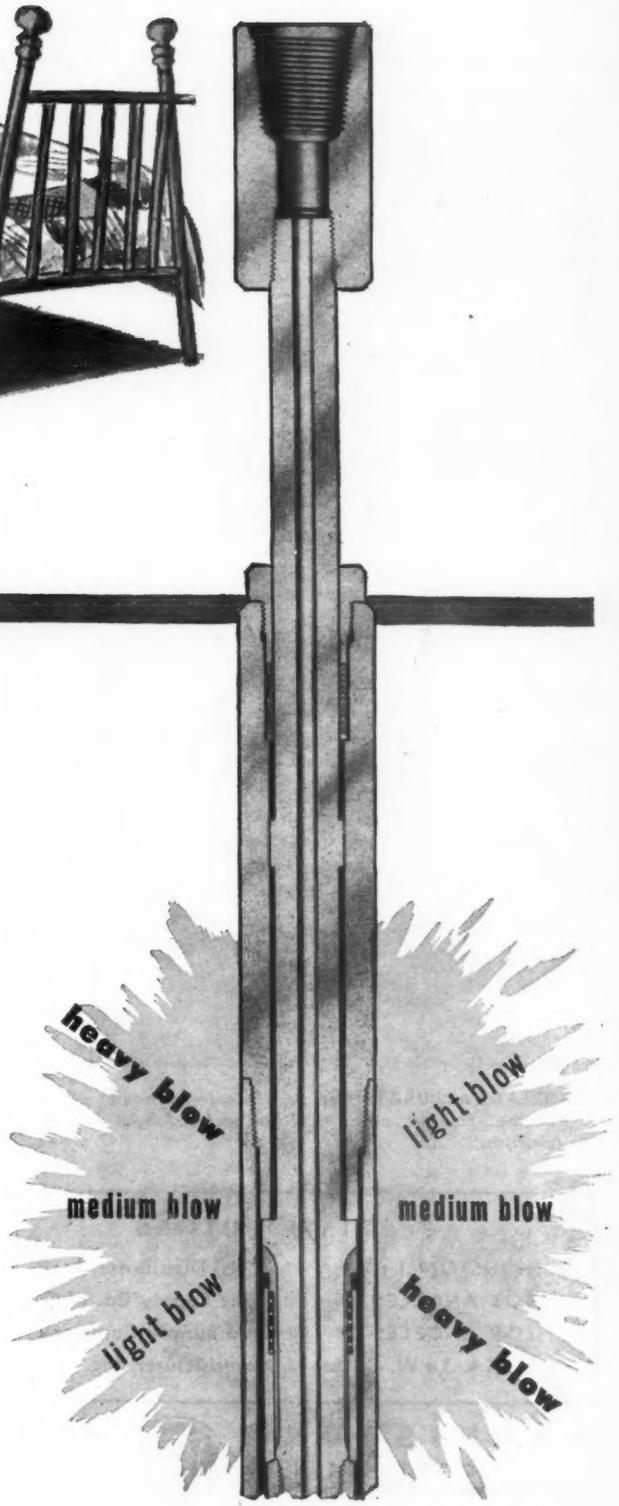

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through beds dipping from 45 to 65 deg and a maximum hole deviation of 1½ deg has been held. The penetration rate is normal for that bit weight. The significant factor is that the 14,000-lb bit weight with six 7¾-in. OD collars was found by experience to be the maximum permissible weight that could be carried without excessive hole deviation resulting. This value coincides exactly with the results of calculations of drill-stem buckling discussed later in this paper.

Another contractor, drilling in a crooked-hole area with 6¼-in. OD drill collars, presented data demonstrating conclusively that 8000-lb bit weight was critical with that size collars. Hole deviation increased when greater than 8000 lb was run on the bit and decreased when less than 8000 lb bit weight was run. This also checks the calculated results presented subsequently and serves to emphasize the degree by which bit weights may be increased when drill collar outside diameter is increased. An increase in bit weight from 8000 lb with 6¼-in. OD collars to 14,000 lb with 7¾-in. OD collars could produce a significant change in rate of penetration, and hence in the time and cost to drill a well.

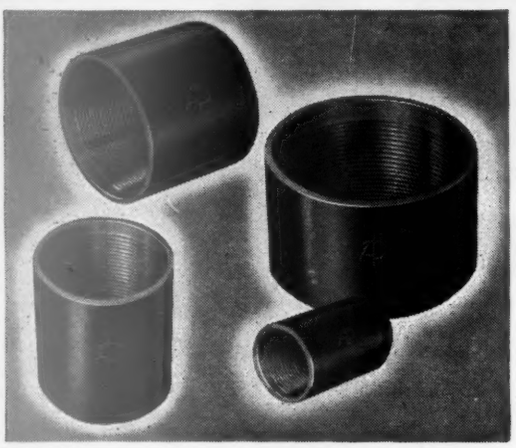
Drill-collar connection failure hazard is reduced when oversize collars are used. The joints are stronger; there are fewer of them in the hole because fewer collars are required to develop a given bit weight; and, because the crews are fully aware of the consequence of a connection failure, more care is exercised with the large collars. One hazard is increased with large collars. There is a greater tendency for large collars to stick while being withdrawn from the hole. There is a premium on sufficient mud circulating equipment capacity to carry out cavings; the bit cuttings are usually fine enough to ride the mud stream satisfactorily, but the large fragments appearing at the surface are all cavings which have been pulverized to the size seen at the surface before they can be carried out of the hole. Cavings boiling above the large collars can develop a sticking hazard during trips that would not be present with 6-in. collars. Inadequate fluid circulation would not be too serious with conventional collars, but could affect seriously the success of an oversize collar program. A theoretical annular mud velocity of 160 ft per minute suffices for most Mid-Continent drilling with average mud conditions, and that velocity can be reduced with safety as the carrying capacity of the mud is increased by treatment.

The second approach to straight-hole drilling, still in the proposal stage, is an outgrowth of some theoretical work reported by Arthur Lubinski.* In that work, Lubinski mathematically developed bit weights that would produce drill-collar buckling and where that buckling would occur. That original work has been expanded and applied to the problem of straight-hole drilling; and it has been found, as above noted, that two drilling contractors have found, by trial and error, that the maximum bit weight that can be carried in crooked-hole country without producing increased hole deviation, is precisely the amount of weight developed mathematically by Lubinski.

This earlier paper concerned a mathematical study of the buckling of drilling strings. Some of the findings are applied here to the problem of drilling a straight hole. They concern only the case in which the weight in mud of the drill collars is larger than the weight on the bit.

The first means of avoiding buckling of drill collars and drilling straight holes is to carry less weight on the bit than the critical value at which the string buckles. There has been a recent trend toward the use of

*"A Study of Buckling of Rotary Drilling Strings," presented at the Spring Meeting of the Mid-Continent District API Division of Production, Oklahoma City, March 1950.



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large drill collars; for example, a string of 8-in. OD in a 9-in. hole allows one to carry appreciable weight on the bit while still keeping the string straight. Means of determining these critical values of the weight on the bit for various collar sizes and mud weights will be given below.

If the formation is too hard to be drilled economically with a weight on the bit which does not buckle drill collars, then the use of one or two stabilizers is advisable. A stabilizer, in order to be effective, should be located in the string at the place at which the deflection of a buckled string is a maximum. Such a location is illustrated in Fig. 1. Means of determining the correct location of a stabilizer in the string will be given below.

The theoretical determination of critical weights on the bit, above which the string is buckled, has been checked experimentally in the following cases:

1. Laboratory experiments on models.
2. Field results in which it has been found, both for 6¼-in. and 7¾-in. OD drill collars, that straight holes are drilled when the weight on the bit is less than the calculated critical value and that holes go crooked as soon as more weight on bit is carried.

Locating a stabilizer at the point of maximum deflection has been suggested for the first time in a recent study committee meeting and no field results have been reported so far. Laboratory tests on models indicate, however, that the mathematical determination of the point of maximum deflection is correct.

General Approach

Fig. 2 is taken from the above-mentioned theoretical investigation, and only a few points will be recalled here. With a sufficiently small weight on the bit the drilling string is straight. As the weight on the bit increases, a so-called critical value of the first order of the weight on bit is reached, for which the string buckles and its shape is shown by Curve 1. If the weight on the bit is further increased, the shape changes progressively, as shown by Curves 2 and 3. Then, if the weight on bit is increased still more, a so-called critical value of the second order of the weight on bit is reached, and the string buckles a second time; this shape is shown by Curve 4. Curve 3 corresponds to a condition just prior to the buckling of the second order.

A stabilizer should be placed approximately at the point of maximum deflection. T_1, T_2, T_3, and T_4 are the points of maximum deflection in Curves 1, 2, 3 and 4, respectively.

As long as the string is buckled only once, then the points of maximum deflection T_1, T_2, and T_3 are close to each other. A stabilizer located at T_2 is for all practical purposes suitable for curves 1, 2, and 3. Consequently, T_2 has been chosen as the location of a stabilizer for the weight on the bit for which the string is buckled once. So far, the theoretical study has not been conducted for the weight on the bit above the critical value of the second order (Curve 4). It may be assumed that for the weights on the bit between the critical values of the second and third order, the point of maximum deflection is located under, but close to T_4, exactly as for the weights on the bit between the first and second order; the point of maximum deflection has been located close to, but under T_1. Consequently, the point T_5 has been chosen as the location of a stabilizer for the weight on the bit for which the string is buckled twice.

Graphical Solution

Figs. 3 and 4 give the critical values of weight on the bit and the location of stabilizers, respectively. Both are plotted versus the outside diameter of the drill collars. All the curves are doubled to show the results for a 10 and 18 lb per gallon mud, respectively. They concern values of inside diameter which are indicated in Fig. 4. Formulas with which these results have been calculated are given in the Appendix. The curves of Fig 3 delimit three areas. No stabilizer is needed for a weight on the bit which corresponds to a point located in the area designated "straight." For any weight on the bit corresponding to points which are located in the areas designated "1st order" (or "2nd order") in Fig. 3, a stabilizer should be used and the distance between the stabilizer and the bit is shown in the curve designated "1st order" (or "2nd order") in Fig. 4.

In order to illustrate the use of Figs. 3 and 4, consider for example 8-in. OD drill collars. Various information concerning these collars is shown in points A to G and M to Q. This information is also given in the following table:

Drill collar data.

		Weight on bit		Location of stabilizer	
	Order of buckling	Point in Fig. 3	Pounds	Point in Fig. 4	Feet above the bit
10 lb per gallon mud	No buckling	A to B	0 to 17,500		No stabilizer
	1	B to D	17,500 to 34,700	M	104
	2	D to F	34,700 to 51,400*	P*	215
18 lb per gallon mud	no buckling	A to C	0 to 15,800		No stabilizer
	1	C to E	15,800 to 31,300	N	110
	2	E to G	31,300 to 46,300*	Q*	226

*The actual third order critical value of the weight on the bit is not shown, and the corresponding curves of Fig. 3 are only approximated.

If it is expected that the weight on the bit will be close to the limiting value between the first and second orders of buckling, then the use of two stabilizers, to prevent both the first and second order buckling, is advised.

The calculated values of the distance between the bit and the stabilizer are not critical. They may be changed $\pm$ 5 per cent for practical reasons if necessary.

Influence of Mud Weight

It is seen in the above table that mud weight affects little the results, which may be approximately interpolated for drilling-fluid densities other than 10 and 18 lb per gal.

Influence of Inside Diameter

The inside diameter for which Figs. 3 and 4 correspond is marked in Fig. 4. For drill collars between 5¾-in. and 6¾-in. OD, the results for two different values of inside diameter have been plotted. Solid lines correspond to ID = 2⅞-in. and dashed lines to ID = 2¼-in. In order to analyze the influence of ID, consider, for example, 6¼-in. OD drill collars in a 10 lb per gal mud, for which the following information is found in Figs. 3 and 4:

Drill collar data.

	Order of buckling	Weight on bit, pounds	Location of stabilizer above the bit, feet
ID = 2⅛ in.	No buckling	0 to 8500	No stabilizer
	1	8500 to 16,800	90
	2	16,800 to 25,000	186
ID = 2¼ in.	No buckling	0 to 9100	No stabilizer
	1	9100 to 18,100	88
	2	18,100 to 26,800	181

It is seen that the influence of inside diameter on critical weights and on calculated location of a stabilizer is small and may be neglected.

No Stabilizer—Oversized Drill Collars

Fig. 3 shows that in a 10 lb per gal mud, a string of 6¼-in. drill collars is straight only if the weight on bit is smaller than 8500 lb. This weight is

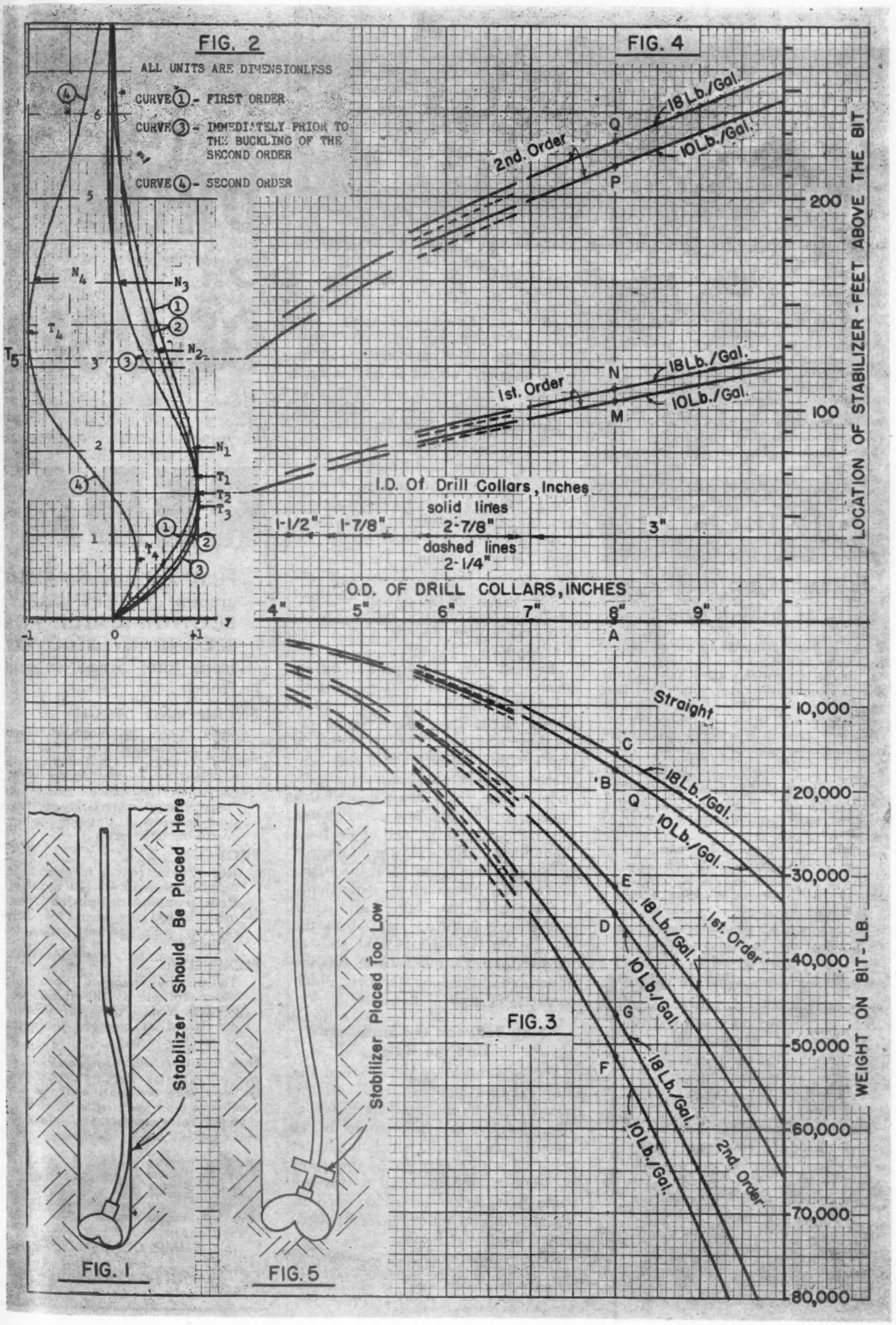
FIG. 2
ALL UNITS ARE DIMENSIONLESS
CURVE (1) - FIRST ORDER
CURVE (3) - IMMEDIATELY PRIOR TO THE BUCKLING OF THE SECOND ORDER
CURVE (4) - SECOND ORDER
FIG. 4
18 Lb./Gal.
10 Lb./Gal.
2nd. Order
1st. Order
I.D. Of Drill Collars, Inches
solid lines
2-7/8"
dashed lines
2-1/4"
O.D. OF DRILL COLLARS, INCHES
LOCATION OF STABILIZER - FEET ABOVE THE BIT
WEIGHT ON BIT - LB.
Straight
FIG. 1
Stabilizer Should Be Placed Here
FIG. 5
Stabilizer Placed Too Low
FIG. 3

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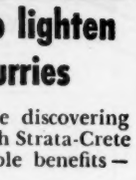

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not sufficient to drill economically most of the formations. For this reason, some operators use larger drill collars and less clearance between the collars and the hole. Fig. 3 shows what may be gained by choosing any large size of drill collar. The following data* for instance, are for a 10 lb per gallon mud.

Outside diameter, inches	Inside diameter inches	The string is straight if weight on bit smaller than pounds
6¼	2⅞	8,500
7	3	11,800
7¾	3	16,000
8	3	17,500
8¼	3	19,200

It is seen that 8-in. drill collars may withstand without buckling more than twice as much weight as 6¼-in. drill collars.

Stabilizer at a Non-Calculated Location

It may happen that a stabilizer in a drilling string is altogether useless. For instance, a short stabilizer acting as a hinge and located to prevent first order buckling, has no effect for the second-order buckling. The explanation is seen in Fig. 2. A stabilizer placed at the level of T_2 has no effect on the buckled curve of the second order, because the deflection of Curve 4 at the level T_2 is nil.

In most cases, however, a stabilizer located in any place is useful to some extent, but its effect is the greatest if placed at the level of maximum deflection. Consider, for instance, a string of drill collars and a stabilizer placed too low, as shown in Fig. 5. It is obvious from inspection of this figure that if there is any play between the stabilizer and the wall of the hole, the influence of this play is minimized if the stabilizer is raised in the string to the level of maximum deflection.

Some trials have been made using a 20-ft long stabilizer right above the bit. Such a stabilizer is analogous to the previous example because it is the upper end of this long stabilizer which contacts the wall of the hole.

Play Between the Stabilizer and the Hole

As far as buckling is concerned, the play between the stabilizer and the hole should be as small as possible. Theoretically, the best would be to have no play at all, which might be achieved with a reamer. As this form of solution is considered to involve some risks, it has been suggested to use as stabilizer an expansible packer which would not rotate.

*These results are slightly different from those of Fig. 7 of the previously mentioned reference in which it has been assumed that inside diameter of large drill collars is proportional to outside diameter.

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Conclusions

1. Increasing the outside diameter of drill collars above those normally used makes possible carrying of considerable bit weights without buckling the string.
2. In the event that it is not possible to drill without buckling the drill collars, then buckling, with its resulting tendency for crooked hole, may be minimized by the use of stabilizers which must be properly positioned in the string.
3. Within the limits of any one order of buckling, one position of stabilizer will suffice for an entire range of weights on bit.

Straight-Hole Drilling Techniques

Lubinski has stated, and it should be re-emphasized, that the bit weights he has shown to be the maximum possible without drill collar buckling, must all come from drill collars. Also, the weight of drill collars in mud, not air, should be considered. For convenient use, the following tabulation gives the effective weight of a drill collar in muds of various densities expressed as a percentage of their weight in air;

Mud weight, pound per gallon	Effective drill-collar weight, per cent of weight in air
9	86.25
10	84.72
11	83.19
12	81.66
13	80.14
14	78.61

The close weight control necessary to permit application of the maximum bit weight possible without drill-collar buckling, places a premium on accuracy in weight indicators. It has been shown that 16,000 lb is the maximum weight that may be carried on 7¾-in. OD collars without buckling. In order to develop the maximum rate of penetration, a driller might be carrying right up to that prescribed maximum bit weight in all good faith; yet if the weight indicator were 2000 lb in error, crooked hole might develop, and the practices herein proposed might be erroneously discredited. A field program of periodic calibration of weight indicators should be an integral part of the overall program. The more modern crown blocks permit dead-line sheave greasing; for many years ungreased dead-line sheaves impaired weight indicator accuracy to a great degree. The importance of reliable surface indication of bit weights cannot be over emphasized.

Reamers, or stabilizers, have been run in drilling strings for many years with no noteworthy success as a straight hole drilling tool. It appears now that seldom, if ever, have they

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been run in the optimum position, and that when not so properly placed they are of little value from a straight-hole standpoint.

The economics of drilling require the maintenance of an acceptable rate of penetration. If bit weights are to be limited in accordance with the above calculations, rock bits must be available that will dig with those weights. Long-tooth bits are the answer in order to create the highest possible unit tooth pressure on the rock, because of the fewer teeth, with a given bit weight. Higher tooth pressures produce greater rates of penetration which is gratifying to all, particularly to the driller who would be less tempted to crowd on slightly more weight than the prescribed amount; more bit weight might well defeat the entire program. Unfortunately, the long-tooth bits currently available lose gage rapidly. As soon as that occurs, some of the weight is taken from the teeth and transferred to the rounded-off portion of the bit. Penetration rates fall and the next bit has hole to ream before reaching bottom. The development of a long-tooth rock bit designed to preserve its gage is urgently needed in the field of straight-hole drilling in crooked-hole country.

A third straight-hole drilling technique has been the use of hammer, or percussion, drills. Although results are far from conclusive to date, there is strong evidence that with hammer action superimposed on a rotating action, the bit weight may be reduced approximately in half without reduction in rate of penetration. If the hole will have a tendency to stay straighter with that reduced bit weight, then some straightening up should result. The hammer drill itself does not straighten a hole; it does produce an acceptable rate of penetration while drilling with the lighter, hole straightening, bit weights. Bit life has been increased with the lighter weights and hammer action; the bits wear less rapidly and a bit too dull to drill satisfactorily with extremely light weights may still be perfectly adequate for hammer drilling.

A fourth technique has been coring, or rat-holing ahead with a small bit and reaming with a pilot hole opening bit. This is expensive because the hole has to be drilled twice, and is desirable only when there is assurance that the small hole can be drilled straight. Core holes have been known to increase the deviation angle sharply. No benefit would result from the pilot reaming of a crooked rat hole. In general, rat-holing ahead would normally be employed as a hole straightening technique, rather than as a means of prolonging the axis of the existing hole.

A fifth straight-hole drilling technique employed to date is the use of a special combination diamond core barrel and rock bit. The tool is short, and is not intended to recover core. A rock bit is positioned inside and just above the core bit and turns with the diamond bit. It grinds up the core as rapidly as cut. The circulating fluid discharges through the rock bit water courses in the normal manner and all cuttings are flushed out past the cutting edge of the diamond core bit. An 8¾-in. diamond head employs a 6-in. rock bit. The tool is designed primarily to provide an acceptable rate of penetration with the lighter bit weights usually employed in crooked hole country. Ordinary diamond core barrels have been employed for this same purpose, but often trouble has been encountered with core blocking and wedging in the barrel. Such trouble is avoided by grinding up the core with the rock bit.

The limited use of this tool to date has given satisfactory results. In one Velma Pool well, 369 ft were drilled with the combination bit at an average penetration rate of 1.65 ft per hour in 11 runs; then 58 ft with rock bits at 1.30 ft per hour in 3 runs; then 93 ft with the combination bit at 1.97 ft per hour in 3 runs. The overall average for the 462 ft of combination diamond-rock bit drilling was 1.71 ft per hour in 14 runs. Rock bit drilling with 3,000 lb bit weight prior to the combination bit run had resulted in a 3½-deg hole deviation. The bit weight with the combination bit was successfully increased to 10,000 lb then to 14,000 lb and the hole deviation was reduced to 1¼ deg. The 3 rock runs then increased the deviation to 2¼ deg with 5000 lb bit weight. The last three combination bit runs with 12,000 lb bit weight further increased the hole deviation to 3½ deg. The greater penetration rate with the combination bit was undoubtedly due to the greater bit weight used. This limited experience to date is not sufficient to permit the drawing of any general conclusions.

The Study Committee on Bore Hole Drift presents the above data as an interim progress report after its first year of existence. Additional work is planned.

Appendix

According to the previously mentioned paper by Arthur Lubinski, the length of one dimensionless unit m is equal to:

$$m = \sqrt[3]{\frac{EI}{p}} \quad . \ . \ . \quad (1)$$

wherein:

E designates Young's modulus of steel;

I designates the moment of inertia of the cross section; and

p designates the weight *in mud* per unit length.

The moment of intertia I of the cross section is equal to:

$$I = \frac{\pi\ (D^4 - d^4)}{64} \quad . \ . \quad (2)$$

wherein:

D and d stand for the OD and ID of the drill collar respectively,

p may be expressed as function of D, d and densities σ and w of steel and mud respectively.

$$p = \frac{\pi\ (D^2 - d^2)\ (\sigma - w)}{4}$$

. . . . . (3)

Substituting (2) and (3) into (1), we obtain:

$$m = \sqrt[3]{\frac{E}{16}\,\frac{D^2 + d^2}{\sigma - w}}$$

. . . . . (4)

All the symbols in the relationship (4) concern a consistent system of units. Consider customary units, that is to say:

Inches for D and d.

Pounds per cubic inch for σ.

Pounds per square inch for E.

Feet for m.

Then formula (4) becomes, after substituting the numerical value for $E = 30 \times 10^6$ psi

$$m = 10.275 \sqrt[3]{\frac{D^2 + d^2}{\sigma - w}}$$

. . . . . (5)

In Fig. 2, the depths are measured in dimensionless units. Then the locations of stabilizers are as follows:

$$a_1 = 1.5\ m \quad . \ . \quad (6)$$

$$a_2 = 3.1\ m \quad . \ . \quad (7)$$

wherein:

a_1 and a_2 are the distance between the bit and the stabilizer for the first and second order of buckling respectively.

The curves of Fig. 4 have been obtained by plotting numerical values calculated with formulas (5), (6) and (7).

The following expressions of critical weights on the bit are taken from the previously mentioned reference:

$$W_1 = 2.04\ mp \quad . \ . \ . \ . \quad (8)$$

$$W_2 = 4.05\ mp \quad . \ . \ . \ . \quad (9)$$

$$W_3 = 6\ mp^* \quad . \ . \ . \ . \quad (10)$$

wherein:

p stands for the weight *in mud* per foot of drill collars.

The curves of Fig 3 have been obtained by plotting numerical values calculated with formulas (5), (8), (9), and (10). ★ ★ ★

*The coefficient 6 is only approximated.

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Flying Magnetometer Survey Near Gulf of Venezuela

AERIAL magnetic studies of a 600 square mile area near the southern part of the Gulf of Venezuela were completed recently for the Venezuelan Atlantic Refining Company.*

The survey was flown at an altitude of approximately 300 meters over a rectangular grid pattern with the flight lines spaced at intervals of one and two kilometers. Flight traverses for data control purposes intersected the flight lines at 10 km intervals.

Much of the survey area is under water, so the mapping plane was Shoran-guided. Shoran is an electronic plane-positioning device, developed during World War II for precision bombing. It was first used in oil exploration in the areomagnetic survey of the Bahamas 4 years ago. With Shoran's aid, it was possible to maintain the survey plane on its course within a positional tolerance of 150 ft during its over-water flights in the Gulf of Venezuela area.

The land areas of the survey tract are level country with easy access roads. It was a simple matter, therefore, to drive the self-contained Shoran trucks to their positions within the survey area. These locations were selected by reference to existing geodetic information. Uusually each station was set up within about 30 miles of the other truck-station. The two stations and plane were in constant communication with each other, through radio transmitters and receivers. Each truck carried its own gasoline-powered generator for the Shoran equipment and radio transceiver.

Flying of the survey and spot checking of the aeromagnetic data were accomplished by the survey staff within a single week's time. The entire operation was based at Maracaibo. Within three weeks after the last survey flight, the completed magnetic maps were delivered to geologists of the Atlantic

*The aerial reconnaissance was performed by Aero Service Corporation of Philadelphia.

Part of the survey group: Francis McWilliams, Richard Brown, Lt. Alberto Cardenas of the Venezuelan Army, Vernon Reynolds, Robert Pate, Joseph P. Mullen, Jr., project manager, Roscoe L. Slaton, geophysical assistant of the Venezuelan Atlantic Refining Company, Glen Gustafson, and Eddie Irwin.

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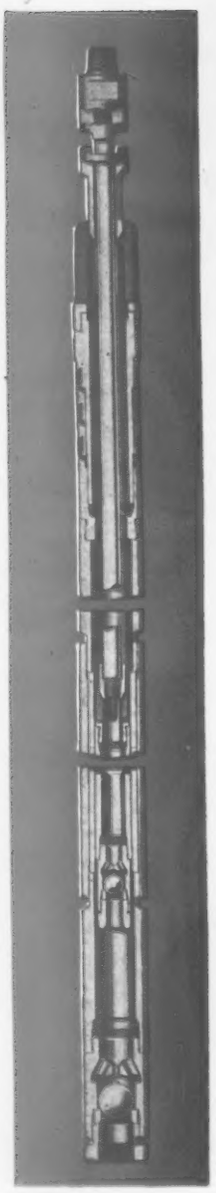

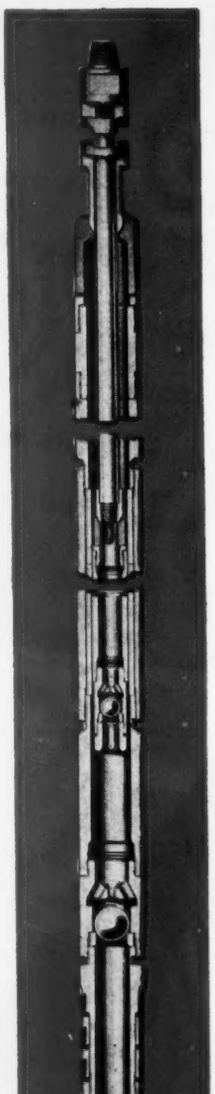

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Refining Company, who will analyze the data. The maps were compiled at a scale of 1:50,000 at a contour interval of 10 gamma, except for some areas where the local gradient dictated a 5 gamma interval. The survey instrument was the Gulf high-sensitivity, airborne magnetometer. The magnetic record is considered accurate to within 1 to 2 gamma.

The survey staff numbered 15 men. It was made up of a pilot, co-pilot, aircraft mechanic, magnetometer operator, four Shoran operators, a radio operator, three data compilers, and three local helpers. The electronic staff was supplemented by Shoran technicians†.

In addition, the survey was aided greatly by Lt. Alberto Cardenas of the Venezuelan Army. He was assigned by his government to aid an aeromagnetic survey by Aero Service Corporation for the Ministerio de Fomento, and then continued his assistance on the oil survey. Lt. Cardenas served as an invaluable liaison between the survey party and Venezuelan local and national officials, as well as helping with radio communications.

The survey plane was a Douglas DC-3, the same plane used in the largest over-water magnetic survey ever made, in the Bahamas in 1947. The Venezuelan Atlantic survey is the first aeromagnetic survey there since the one for Gulf Oil Company in 1948. The study is part of Venezuelan Atlantic Refining Company's broad exploration program.

The survey was made under the direction of Richard C. Harris of Atlantic's home office with assistance from the oil company's personnel at Caracas, who aided the air survey staff greatly in matters of entry permits, licenses, and like problems. Technical Consultant for the survey was Dr. William B. Agocs of the University of Tulsa, who will aid Venezuelan Atlantic in the interpretation of the aeromagnetic data. * * *

†Offshore Navigation Incorporated.

SEG Annual Meeting

The 21st annual convention of the Society of Exploration Geophysicists, held jointly with the American Association of Petroleum Geologists and the Society of Economic Paleontologists and Mineralogists, was held April 23 in St. Louis, Missouri. Approximately 3000 were present. Thirty-three technical geophysical papers were presented, including four before the joint meetings of the three exploration societies. George E. Wagoner, of Shreveport, retiring president of the SEG gave the welcoming address.

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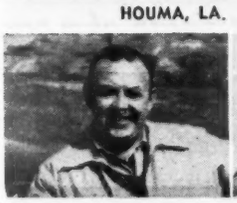
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FIG. 1. General view of 4,000,000-lb capacity precision machine on which tests were made.

Collar Type Elevator in Deep Casing Operations

Tests made to determine effect, if any, of collar type elevator on tensile strength of a casing string.

W. A. WILSON

EVEN in an industry as meticulously scientific as that of petroleum, legend occasionally reaches the stature of fact, and custom and practice become the basis of official approval. There has gradually been adopted among drilling contractors, independent operators, and company drilling departments, for example, an arbitrary ruling with regard to casing elevators, which says in effect, "when the casing string is longer or heavier than such and so, it shall be the duty of the driller to use a slip type elevator." This ruling is usually handed down by the engineering department or some similarly authoritative agency or individual, and yet up to the moment all efforts to determine the fundamental reasons for the imposition of this ruling have been fruitless.

Some time ago a tool pusher for a large west coast oil company raised this very question—why must a slip type elevator be used beyond a certain depth? His question was referred to the engineering department whence the ruling emanated, and after going into a huddle the engineers frankly admitted that they didn't know. They in turn passed the query on to the local representative of a highly reputable national manufacturer of pipe and an equally well recognized manufacturer of casing elevators. They didn't know either!

It seemed apparent then that no research had ever been undertaken to determine the effect, if any, of a collar type elevator on the tensile strength of a casing string. In other words, to establish the relationship between the strength of the string suspended in a collar type elevator, and the strength of the same string independent of the elevator or any other extraneous action or influence. The question at issue was simply this: Does the use of a collar type elevator reduce the load carrying capacity of a threaded coupling, or in any other

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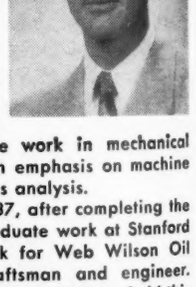
The Author



W. A. Wilson's high school education was received at the Harvard Military School in Los Angeles and his college education was received at Stanford University, from which he was graduated in 1936. His major subject at Stanford University was mechanical engineering.

After graduating from Stanford, he returned to take one year of post-graduate work in mechanical engineering with emphasis on machine design and stress analysis.

In June of 1937, after completing the year of post-graduate work at Stanford he went to work for Web Wilson Oil Tools as a draftsman and engineer. From then until March 1942 he held this position and also did some outside consulting work in mechanical engineering for the E. B. Wiggins Oil Tool Company in Los Angeles.

In March 1942, he went on active duty with the Ordnance Department of the United States Army where he was in the Procurement Office until October of 1945.

Upon returning to civilian life he again returned to Web Wilson Oil Tools in charge of production. In 1946, he became vice president in charge of production. This post he still holds.

manner lower the tensile strength of the casing string?

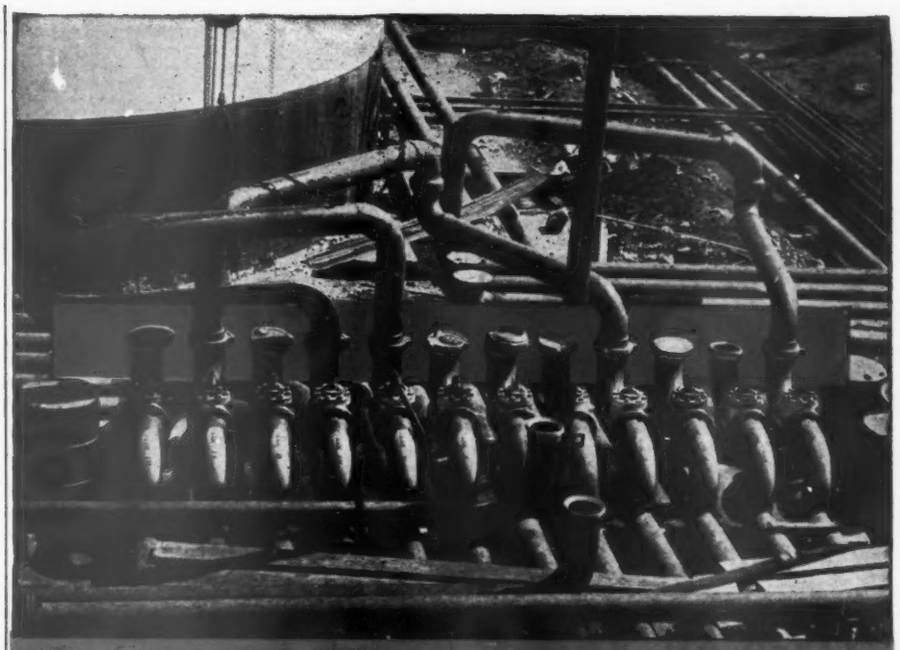
In order to develop pertinent data on this operating problem, a series of tests was recently conducted in the Engineering Materials Laboratory of the University of California at Berkeley. It was decided to use 7-in. OD casing in the tests, because that size is the most widely used in the entire API list. To keep the total loads within the range of the rated capacities of currently manufactured side door elevators, 7-in., 26 lb, J-55 short thread and coupling casing was selected, and for comparative purposes it was agreed that casing of the next lower weight should also be included, that is, 7-in., 20 lb, J-55 short thread and coupling casing.

Five samples of casing were cut from each joint of pipe. The pieces were then all threaded on one end with a short API 8-round thread. A coupling was next screwed to three of the five pieces in each instance for test with the collar type elevator†, and the remaining two pieces in each instance were joined with a coupling to form a hypothetical casing string section, for a test of coupling strength alone. This sample arrangement, it will be noted, provided for each weight of casing, three pieces to determine the strength with elevators, and one piece to determine the strength without elevators.

To keep the conditions of the tests as uniform as possible all samples were threaded on the same machine, in which new dies had just been installed. When completed, the threads were carefully checked. The figures obtained are recorded in the accompanying tabulation. (Table 1) Threaded ends were measured for wall thickness at four points in each instance, and the average of these measurements is also shown in the table. The power tight stand-off, too, is shown in Table 1. It is also worthy of remark that in selecting the two pieces to be coupled together, an effort was made to choose pieces with an average wall thickness as near as possible to the general average wall thickness of all pieces in that particular casing size and weight.

In making the actual tension tests, a 4,000,000 lb capacity precision, universal testing machine was used. The casing specimens, where they were not supported by the elevator, were gripped in the jaws of the testing machine in the usual manner, and were supported against crushing by internal plugs. All specimens were of sufficient length to eliminate the effect of stress concentrations caused by the gripping

†Web Wilson, 150 Ton, Type AC Sidedoor Casing Elevator.



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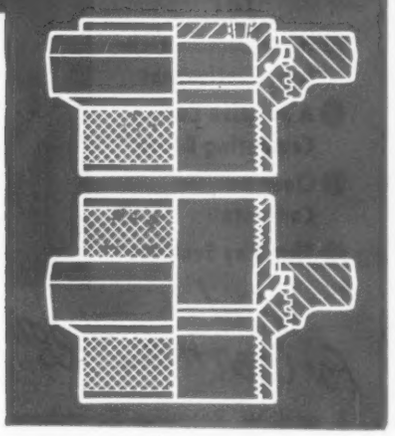

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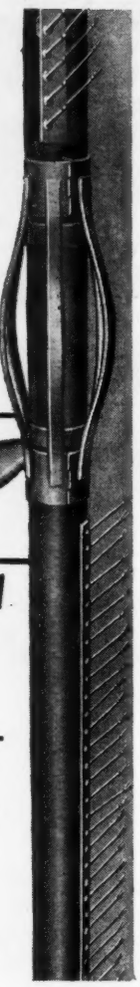

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TABLE 1.

Description of samples	Sample number	Average all thickness	Power tight stand-off	Load at failure	Remarks
7 in.—20#—J-55, ST&C	1 A	.275	0	293,000	
7 in.—20#—J-55, ST&C	2 A	.272	1	304,000	
7 in.—20#—J-55, ST&C	3 A*	.280	1	303,000	3 A pulled out of collar
7 in.—20#—J-55, ST&C	4 A*	.281	½	303,000	
7 in.—20#—J-55, ST&C	5 A	.281	1	303,000	
7 in.—26#—J-55, ST&C	1 B	.362	0	425,000	
7 in.—26#—J-55, ST&C	2 B	.359	½	397,000	
7 in.—26#—J-55, ST&C	3 B*	.362	0	432,000	3 B pulled out of collar
7 in.—26#—J-55, ST&C	4 B*	.361	0	432,000	
7 in.—26#—J-55, ST&C	5 B	.365	0	414,000	

* 3A and 3B as well as 4A and 4B were coupled together to form the hypothetical joints of pipe for the respective sizes.

TABLE 2.

Type casing	Loads with elevator		Loads with coupling	API joint strength	
	Average	Maximum	Maximum	.80 Safety	Average
7 in.—20 lb Short Threads	300,000	304,000	303,000	203,000	254,000
7 in.—26 lb Short Threads	412,000	425,000	432,000	276,000	345,000*

* Tentative

jaws. The procedure was to carry the tests to the point of destruction and in each case three tests were made with the casing elevator bearing against the coupling (Figs. 1 and 2), and one was made with the ends of the coupled pieces held in the grip jaws of the testing machine as described above.

The 7-in. side door casing elevator used in this investigation was supported in a standard set of 2¾ in. by 108 in. weldless elevator links, the upper eyes of the links were pinned into a large clevis, which in turn was held in the upper grip jaws of the testing machine. Thus, the elevator, links, and casing were in substantially the same relationship as they would be in actual field use. The results of the tension tests are also included here in tabular form. (Table 2)

FIG. 2. Closeup showing test with collar-type elevator. Note safety cable to keep sample under control.

Perhaps before attempting to draw any conclusions from these results, however, it would be advisable to consider briefly some of the involved factors, and to attempt to appraise the significance of the differences noted. To begin with, it must be remembered that we are dealing with a testing machine having a capacity of some 4,000,000 lb. That is a very large machine and, of course, its inherent error must be correspondingly high. Percentagewise it can have the same accuracy as a smaller and more delicate machine yet the straight numerical deviation may be an imposing figure. One half of one per cent of 4,000,000 is still 20,000, so of course one must not allow oneself to be stampeded into an erroneous deduction by mere magnitude.

Along this same line, it will at once be realized by anyone with a sense of scientific exactitude that the threading of five pieces of pipe with perfect uniformity is a physical impossibility, and that the eventual makeup of these pieces of pipe into comparable positional relationship is equally difficult to contrive. It is quite certain that regardless of the amount of care exercised to maintain comparable conditions for all tests, the combination of errors that are inherent and that can't, therefore, be kept out are more than enough to account for all the differences that were found in the tests.

It will be noted in the accompanying tabulations, too, that there were apparently minor differences in thread taper and average wall thickness. These differences expressed in the ordinarily employed terms seem quite insignificant, but if their relationship to tensile strength is even remotely di-

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rect, they can be responsible for very much larger discrepancies than were found in the tests. It is well realized that since there was no failure of the pipe itself, variations in pipe thickness lose some of their import, but there can be no doubt that both the character of the thread itself and the strength of the made-up coupling are in decided measure affected by these irregularities in wall thickness.

Just by way of example, the widest variation in average wall thickness of the 20-lb casing was .009 in. and in the 26-lb, it was .006 in. These represent approximate differences of 3.2 per cent and 1.6 per cent respectively. It is obvious that if tensile strength were directly proportional to wall thickness, these differences would also result in sizable disparities; indeed, disparities quite comparable to the ones that were actually found.

All this is merely preliminary to a rational consideration of the results and particularly to make it plain that the tension differences that occurred between the two main classes of samples lie in most instances comfortably within the error of the testing system. It is interesting in this connection that greater discrepancies occurred between the high and the low measurement in the elevator tests, than between the average of the elevator tests and the coupling strength test in each instance.

All failures resulted in the couplings being pulled off the threads. In no instance was there an actual rupture either of casing or coupling. And with these facts understood, careful consideration of the results seem to justify the following conclusions:

1. When pulling 20-lb casing with collar type elevators, there is no significant reduction in joint strength.
2. When pulling 26-lb casing with collar type elevators, the tests indicate a slight reduction in joint strength, but this seems to be within the error of the test system itself and is consequently not conclusive.
3. Nothing in the tests indicates that there is any disadvantage in the use of a side-door collar type elevator, regardless of drilling depth.
4. Good operating procedure does not permit the loading of casing or coupling, even in slip-type elevators, to loads anywhere near those encountered in the tests. It is reasonable to conclude, therefore, that a collar type elevator has no ill effect on the casing.

One of the principal objections that has been registered against the use of collar type elevators in days gone by is that the operator had no assurance that the couplings had been made up properly by the mill. With modern day mill practices the possibility of an improperly made up coupling is most remote.

In view of the foregoing and of the time-saving possibilities of a collar type elevator because of its light weight and ease of operation, and also the fact that the casing is free from potential damage because of the absence of any wedging action, perhaps greater consideration should be given to the use of collar type elevators for deep casing operations. * * *

Penn Grade Crude Expected to Decline

Pennsylania crude oil production is expected to decline this year, according to George J. Hanks, president of South Penn Oil Company. Hanks disclosed that production for 1951 is estimated at about 54,500 bbl daily. Last year Pennsylvania crude oil production averaged 56,386 bbl per day. The 1949 average was 56,178. Hanks added that drilling and development during the last 24 months have not been sufficient to maintain the current rate of production.

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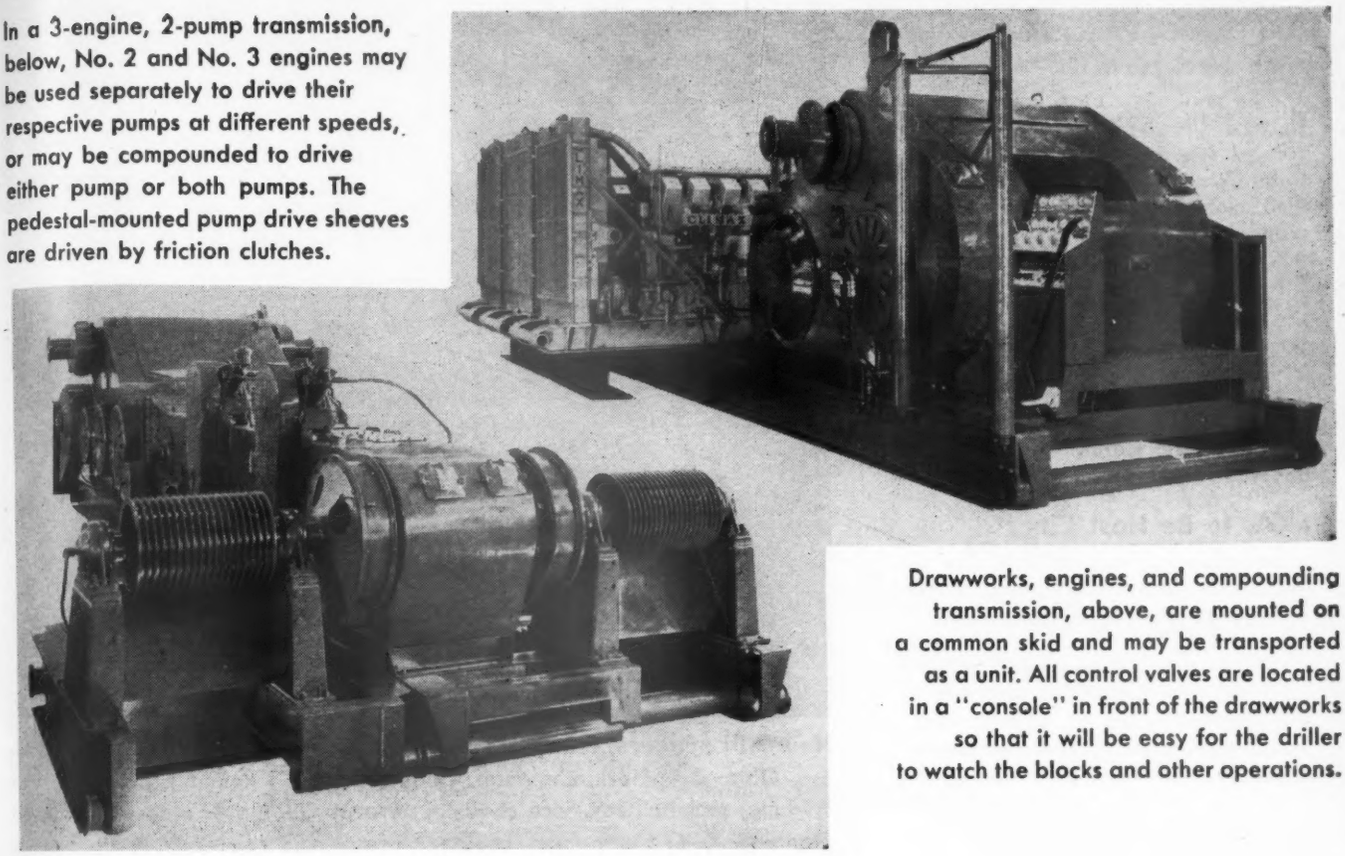
In a 3-engine, 2-pump transmission, below, No. 2 and No. 3 engines may be used separately to drive their respective pumps at different speeds, or may be compounded to drive either pump or both pumps. The pedestal-mounted pump drive sheaves are driven by friction clutches.



Drawworks, engines, and compounding transmission, above, are mounted on a common skid and may be transported as a unit. All control valves are located in a "console" in front of the drawworks so that it will be easy for the driller to watch the blocks and other operations.

New Skid-Mounted Rig Offers Compactness

Interchange of prime movers is simple procedure on this 800-hp, two-mud-pump, air-controlled rig for use with a portable derrick

An 800-hp power-type drilling rig[1] designed for use with a portable derrick is now at work on a wildcat location near Big Lake, Texas, for the Brinkerhoff Drilling Company of Dallas. The drawworks, with built-in selective transmission, engines, and compounding transmission are mounted on a common skid and may be transported as a unit. It is similar to smaller rigs of the same series in that it can be rigged up and torn down without breaking chains or disconnecting air lines or oil lines. This feature should save time and money in moving from one well to another, and the similarity of this rig to others should give the operator more flexibility in assigning men and rigs to various locations.

The installation of the two mud pump drives in line at the tail end of the compounding transmission permits the pumps to be mounted in line, thus simplifying the manifolding. The mud pump drive shafts are divided, so that the pumps may be operated at different speeds.

Although the width of the rig was kept down to make it easier to handle on the road and easier to install on portable derricks, the drawworks drum and auxiliary equipment is designed large enough to handle the necessary wire line and perform the work required. The main brakes are 46-in. in diameter, the "full-wrap" type, having a 350 deg arc of contact with a 54 to 1 mechanical linkage ratio. The brake rims are enclosed and cooled by forced circulation of water.

The first model is powered by three 280-hp, V-8 gas engines,[2] however, the rig may be powered with either two or three engines having a combined maximum horsepower output up to 900. It is not necessary to remove the engines or tear down the rig for moving except to meet road requirements in certain areas. Removal and reinstallation of the engines doesn't require the breaking of chains, air lines, or oil lines.

All valve controls[3] and heavy duty gages[4] are located in a console mounted in front of the drawworks at the driller's position. The rig is different from others in the same series in having a friction clutch on the low side of the drum drive and the double mud pump drive at the back of the compounding transmission.

[1]The "GB-800" announced recently by Emsco Derrick & Equipment Company and Continental Supply Company, Dallas, Texas.

[2]Model V-80, manufactured by Climax Engine & Pump Company, Clinton, Iowa.

[3]Manufactured by Marsh.

[4]Manufactured by Westinghouse and Valvair.

* * *

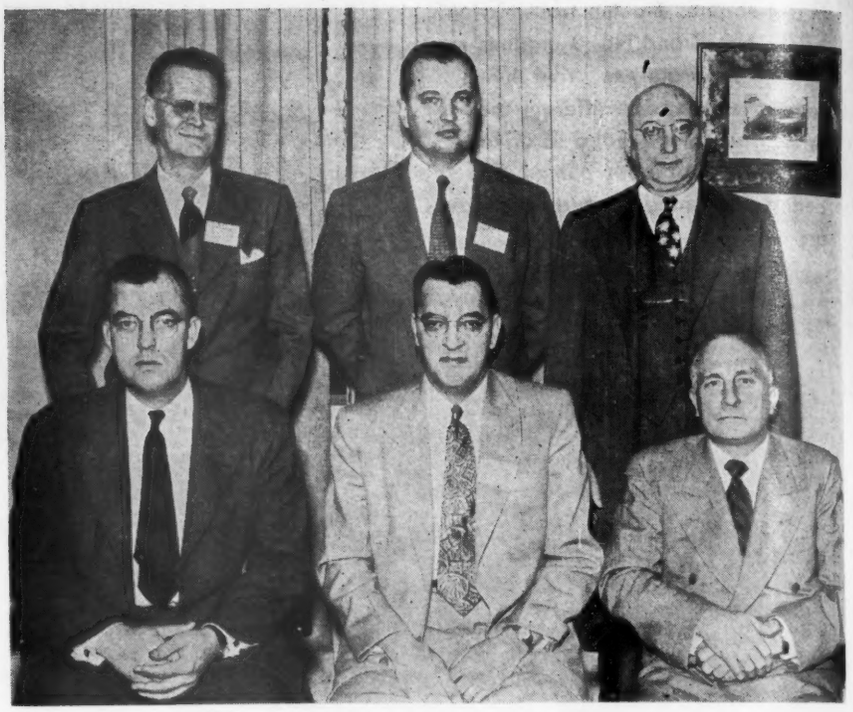
API Eastern Production Men Elect New Officers

The American Petroleum Institute Eastern Production Division elected new officers at its spring meeting in Columbus, Ohio, recently. Vice chairmen elected and not shown in the photo at right are: R. W. French, Sohio Petroleum, Cleveland, Ohio; John T. Galey, independent producer, Pittsburgh; Paul Benedum, Hiawatha Oil, Pittsburgh; T. C. Stauffer, Sun Oil, Evansville, Indiana.

Below are oil and gas executives who received citations for outstanding service at the Columbus banquet of the API Division of Production.

L. A. to Be Host City

Los Angeles will be host city for the 1952 annual convention of the American Association of Petroleum Geologists, professional organization with a world-wide membership totaling 8000. Word of official approval of Los Angeles as the site of next year's March convention by the association's executive board was received by Frank A. Morgan, exploration vice president of Richfield Oil Corporation and AAPG president-elect. Next year's convention will be the first held in Los Angeles since 1947. The annual session was also held there in 1937.



New API officers, seated: Jack Cashell, vice chairman, Preston Oil, Columbus, Ohio; E. T. Heck, chairman, Quaker State Oil Refining, Bradford, Pennsylvania; Marshall Joy, vice chairman, Brazos Oil, Mount Pleasant, Michigan. Standing: K. C. Cottingham, chairman of advisory committee, Ohio Fuel Gas, Columbus; R. L. Bird, Jr., secretary-treasurer, Columbian Carbon, Charleston, West Virginia, E. E. Roth, vice chairman, Columbia Engineering, New York.

Citation for service awards were conferred on 18 men at the API meeting in Columbus, Ohio recently. Awards were presented by J. C. Donnell II, API vice president for production, to: Seated, Frank M. Brewster, Belmont Quadrangle Drilling, Bradford, Pennsylvania; J. French Robinson, East Ohio Gas, Cleveland; J. G. Montgomery, Jr., United Natural Gas, Union City, Pennsylvania; J. H. Newton, Equitable Gas, Pittsburgh. Standing, J. C. Askam, The Ohio Oil, Findlay; J. J. Schmidt, East Ohio Gas, Cleveland; V. F. Bowyer, The Peoples Natural Gas, Pittsburgh; J. V. Goodman, Equitable Gas, Pittsburgh; O. W. Van Petten, Columbian Carbon, Charleston, West Virginia; D. T. Ring, Preston Oil, Columbus; R. B. Anderson, Columbian Carbon, Charleston; H. H. Phillips, Phillips Drilling, San Antonio, Texas; S. M. Vockel, Waverly Oil Works, Pittsburgh; and F. E. Eckert, Handly and Bird, Bradford. Recipients not shown are: W. L. Estabrook, Morristown, New Jersey; M. G. Gulley, Gulf Oil, Pittsburgh; W. E. Ferguson, Ohio Fuel Gas, Columbus, and Christy Payne, Jr., Peoples Natural Gas Company, Pittsburgh, Pennsylvania.

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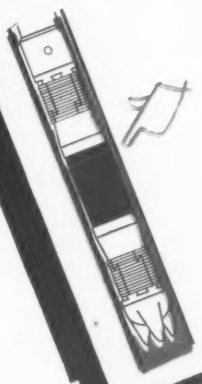

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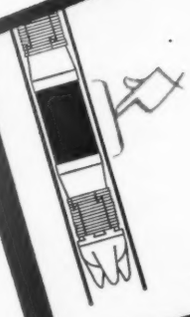

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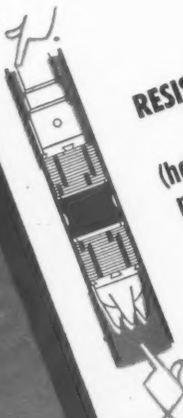

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L. A. 1951 Officers are: W. H. Sargent, assistant sergeant-at-arms; W. A. Wilson, secretary; Earl M. Rees, vice president; Earl M. Boggess, regents junior; J. A. Engstrand, president; Lee J. Laird, regents senior; John H. Flanagan, treasurer, and James D. Hughes, sergeant-at-arms. New officers are pictured at the Nomads inaugural ball.

Los Angeles Nomads Enjoy Sports Program

Los Angeles chapter of Nomads gathered in the Jonathan Club recently to hear a program planned by Bill Sargent, Sargent Engineering Corporation. Bill, himself a figure of prominence in the sports world, came up with a terrific array of sports talent, led by the incomparable Mickey Walker, who in his day held the middleweight, welterweight, and light heavyweight championships of the world. Mickey is now a successful artist and in addition to that is a very entertaining public speaker. Hal Berger, radio sportscaster who beams a 24-hour program to the fighting forces in all parts of the world also did an excellent job of recounting his adven-

Some speakers at the March meeting of L. A. Nomads are shown above: Hampton Poole, assistant coach, Los Angeles Rams; W. H. Sargent, Sargent Engineering Company, toastmaster; Fidel La Barba, retired world's flyweight boxing champion, now sports editor of the Santa Monica Outlook, and Al Santoro, sports editor, Los Angeles.

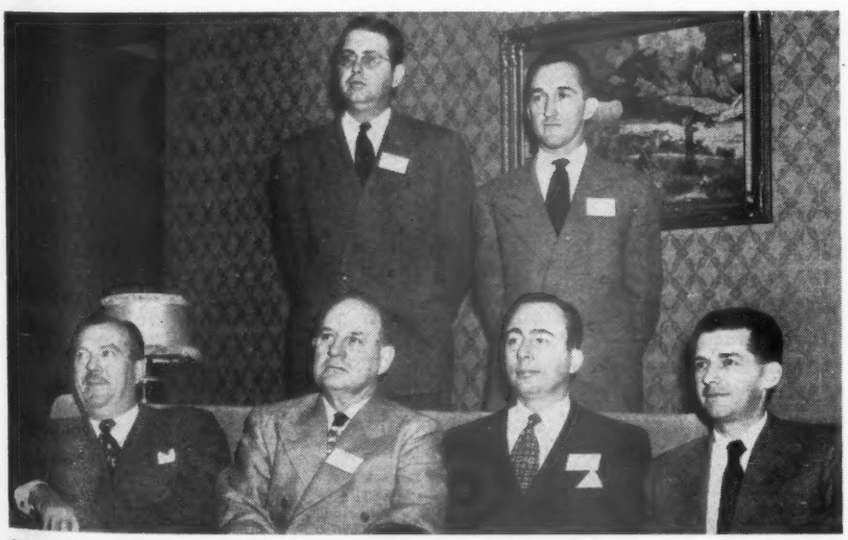
Past Presidents of the Los Angeles Chapter of the Nomads are shown above: R. J. Eiche, Fred C. Ripley, Jr., Henry W. Pullman, Elmer L. Decker, W. F. Bettis, Ted Sutter, Lee J. Laird, and Earl N. Boggess, Jr.

tures in the field of baseball, and he talked intimately and excitingly of many great games and great players.

Fidel La Barba, retired flyweight champion of the world and now sports editor of the Santa Monica Outlook, was next to take the rostrum and he thrilled the audience tremendously with dramatic accounts of some of his toughest battles, particularly the ones with Johnny Vacca and Bud Taylor. Then followed Hampton Poole, assistant coach of the Los Angeles Rams, with a fine sense of humor and some intriguing inside stuff on the gridiron greats. Last but far from least was Al Santoro, sports editor of the Los Angeles Examiner who recited highlights and intimate facts in the careers of such noted newsfolk as Tad Dorgan, Hype Igoe, Rube Goldberg, and Bob "Believe It or Not" Ripley, most of whom apparently began with the San Francisco Bulletin.

Present to enjoy the festivities, besides the regular members, were many guests from foreign fields, among them W. B. Hays, drilling superintendent for International Petroleum; Fred Gholson, Loyd Marolf, William J. Chancellor, W. H. May, Leon Duane, T. D. Parnell, and Harry Bartlett, all recently returned from Drillex service in Argentina; W. P. Ries, just back from the Philippines; Leopoldo Ruiz, Pemex engineer; Hugh Thompson and Russell Bales, from Standard of Cal operations in Venezuela, and Tony Gano, about to depart for Sumatra in behalf of Cal-Tex. * * *

Visitors and new members at Dallas-Fort Worth Nomads March meeting are: Mike Hazel and Lloyd Tracey, Oil Well Supply Company; J. H. Teer, Reed Roller Bit Company; D. J. Cummins, and C. W. Beck, Cummins Engine Company.



Citations for exceptional service in past years were presented to a group of seven oil men (or their representatives) from the Panhandle and Mid-Continent area at the close of a three-day American Petroleum Institute production division meeting in Amarillo recently. Six of the seven are pictured above. They are: Sitting, H. E. Zoller, Derby Oil Company, Wichita, Kansas; L. A. Ogden, Pure Oil, Tulsa; Harold S. Kelly, Phillips Petroleum, Bartlesville; William L. Herner, Sunray Oil, Tulsa, Standing, Harold E. Berg, representing citation recipient W. E. Best, consulting engineer, Pauls Valley; George C. Howard, representing citation winner Lloyd E. Elkins, Stanolind Oil and Gas, Tulsa. R. C. Kay, independent operator, Amarillo, was seventh winner.

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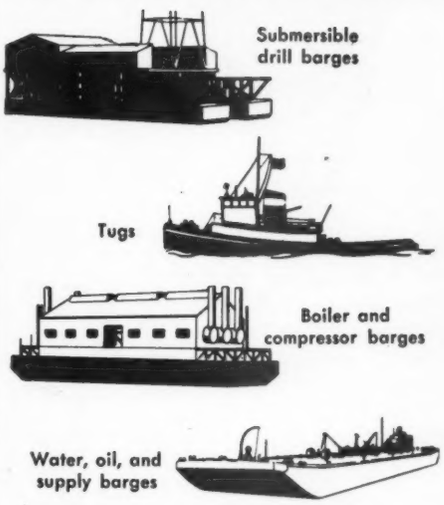

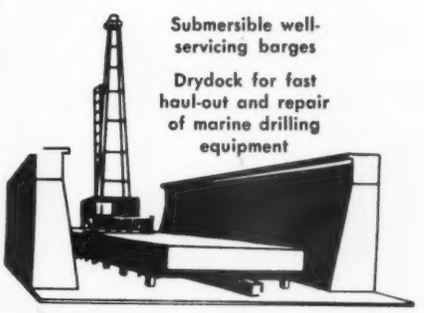

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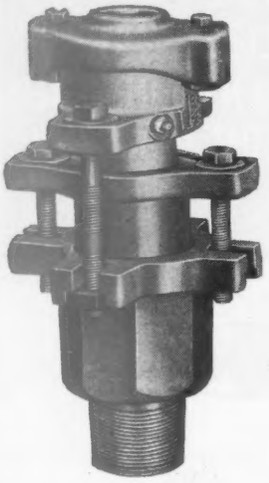

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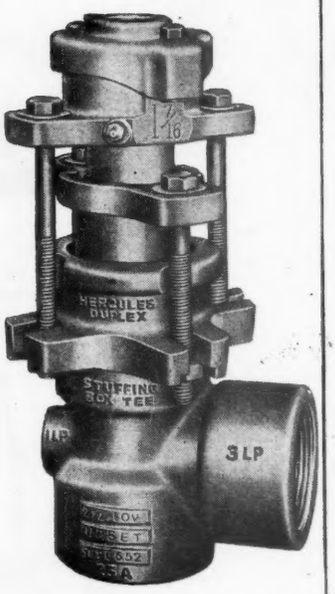

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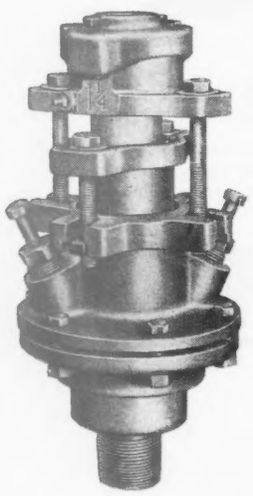

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Floyd Hatfield and Earnest Granville, Gulf Oil Company, were guests at a recent meeting of Dallas-Fort Worth Nomads. Hatfield gave an illustrated talk on oil activity in the Near East.

Geologists to Meet in Utah

The Intermountain Association of Petroleum Geologists is holding its second annual field conference in Millard County, Utah, May 23, 26. The conference committee is under the direction of Graham Campbell of the Phillips Petroleum Company, and a guide book is being prepared under the editorship of Dr. William L. Stokes of the University of Utah.

Geophysics Aids Oil Exploration

The increasing use of geophysics as a tool in the search for essential metallic ores has led the Society of Exploration Geophysicists to consider the organization of a mining section, according to Dr. Sigmund Hammer of Gulf Research and Development company, Pittsburgh, Pennsylvania, vice president of the society.

Although the SEG was organized in 1930 as a scientific group devoted mainly to promotion of geophysics in oil exploration, many of the methods developed during the following years have been used also by mining scientists seeking new metallic ore deposits. Dr. Hammer stated that a mining geophysics section within the society would provide a better opportunity for oil and mining geophysicists to exchange ideas and thus aid in the development of more efficient techniques in both industries.

Northwestern Refining To Buy North Dakota Oil Production

Northwestern Refining Company in St. Paul, Minnesota, will buy the production of North Dakota's first oil well. Elmer Erickson, general manager of Northwestern, said the refinery's contract with Amerada Petroleum Corporation provides that Northwestern will be the only purchaser of crude oil produced on a large acreage of land in the Tioga, North Dakota area. The contract will give Northwestern, manufacturers of industrial lubricants, a closer source of crude oil supply. Most of its crude oil now comes from Wyoming, Montana, and areas further south. The well is expected to produce approximately 10,000 gal a day.

Osment Named Stanolind Geologist

Frank C. Osment is the new division geologist for Stanolind Oil and Gas Company's Texas-Louisiana Gulf Coast division. He was formerly district geologist at Shreveport.

Osment is a native Alabaman and was born in Birmingham in 1918. He was graduated from Birmingham-Southern College in 1939 with a BS degree in geology, and received his MS in geology from the University of Illinois in 1941.

He joined Stanolind in October of 1945 as a geologist at Shreveport, Louisiana, advancing to district geologist for the Southeast district, central division, in 1949. Osment will fill the position vacated by Russell A. Weingartner, who transferred to the general office as senior staff geologist.

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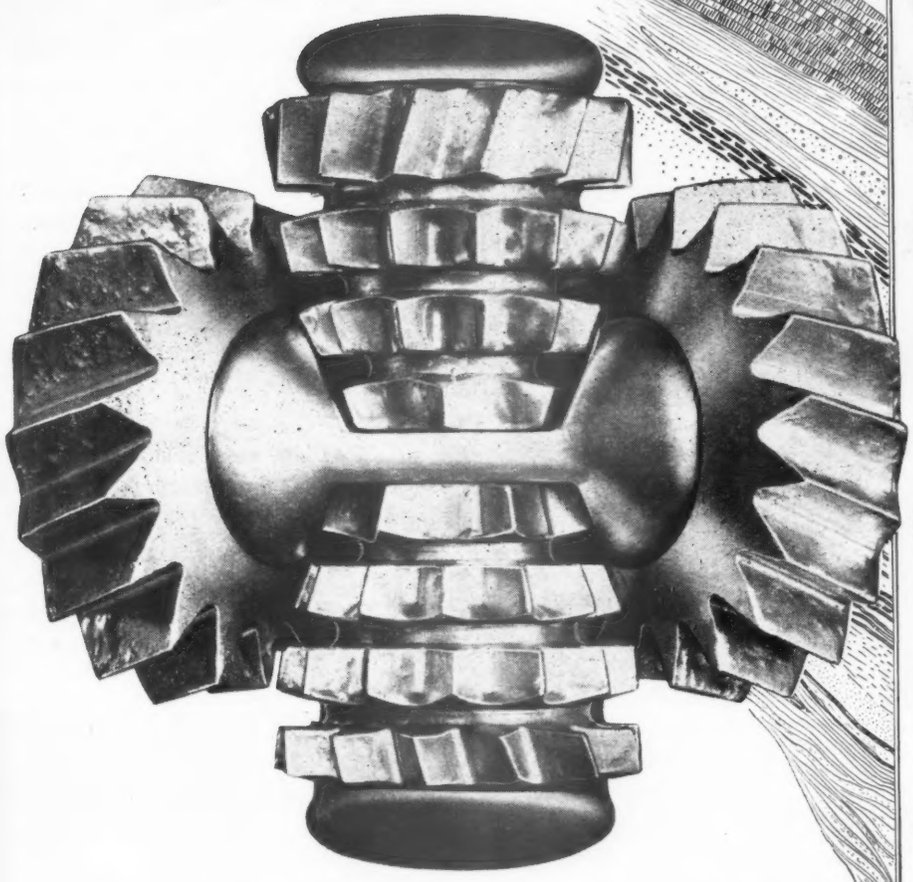

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Long tooth bit for soft formations.

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For soft to medium formations.

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For medium to medium-hard formations.

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For hard rock formations interspersed with extremely hard abrasive streaks.

Security Rock Bits assure straight full gauge hole at a maximum drilling rate through all types of formations. Each Security Rock Bit is designed and field proven to give the best performance under a specific set of conditions. All Security Rock Bits have the advantages of HIGH CENTER CONE bit stabilization, balanced bearings, rugged construction and maximum service life.

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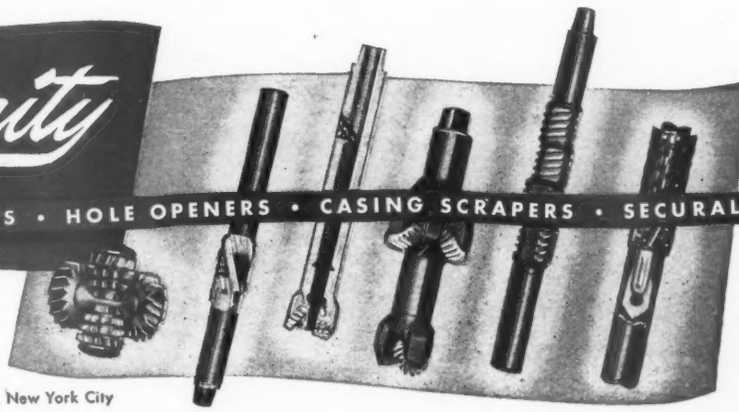

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Dallas-Fort Worth Nomads

Among those present at the recent meeting of the Dallas-Fort Worth Nomads were: Jimmy Hogue, Hughes Tool, Shreveport; Courtney J. Berlin, Baker Oil Tools, and chapter president, and Park J. Myers, Hughes Tool.

Above, are J. E. Everroad, Mid-Continent Cummins Export Corporation, and 1951 treasurer of the chapter; L. W. Beck and Don Cummins, Cummins Engine Company, Inc., Columbus, Indiana, at the Fort Worth meeting of Nomads.

At left, new members initiated at the Dallas-Fort Worth Nomads meeting, are: Walter Leseman, Hydrill Company, A. M. Birnie, Security Engineering Company; Hank Davis, Twin-Disc Clutch; Abbott Sparks, *The Petroleum Engineer;* J. A. Kelly, Reed Roller Bit.

Other Nomads at the meeting were, below: Earle Smith, National Tube Company, Dallas; John H. Teer, Reed Roller Bit, Houston; K. B. Winstead, and M. F. Hazel, Oil Well Supply, Dallas.

Above, early arrivals for the Nomads meeting were Warren J. Jackson, Greenbrier Oil Company, Fort Worth; Kenneth Daggert, and Robert McLemore, Welex, Fort Worth; and J. A. Kelly, Reed Roller Bit, Houston, Texas.

Helicopters Aid Oil Search

A roof-top landing field for helicopters carrying oil exploration crews will be in operation in August or September, 1951, atop the new Humble Oil Company building, to be completed late this summer, in New Orleans.

The landing field will be operated by the Petroleum Bell Helicopter Service and it will mark the first regular air service directly into the heart of New Orleans. It is expected that approximately 12 departures and landings will be made daily from the roof when the service starts.

The helicopters, equipped with pontoon landing gear, are powered by 200-hp engines and cruise at 75 miles per hour. Each helicopter will carry 3 passengers and equipment.

The Petroleum Bell Helicopter Service makes scores of landings daily in marshes, bayous, on the decks of barges, and on oil platforms in the Gulf of Mexico. The new service will enable oil engineers to fly into the marshes, make their tests, and return "for lunch."

Canada Wells May Produce Sulfur

John C. Dallas, president, Fortune Oils Ltd., has announced his company's plans for recovering sulfur from dry oil wells about 100 miles northwest of Edmonton, Canada. Dallas reported the Davies-Hondo No. 2 well encountered black sulfur beds while Fortune-Roxana-Chisholm No. 1 found sulfur while drilling for oil in 1949. If sufficient sulfur is established, hot water will be pumped into the beds, forcing it up again by means of compressed air, and spraying into metal containers where the carried sulfur will be deposited.

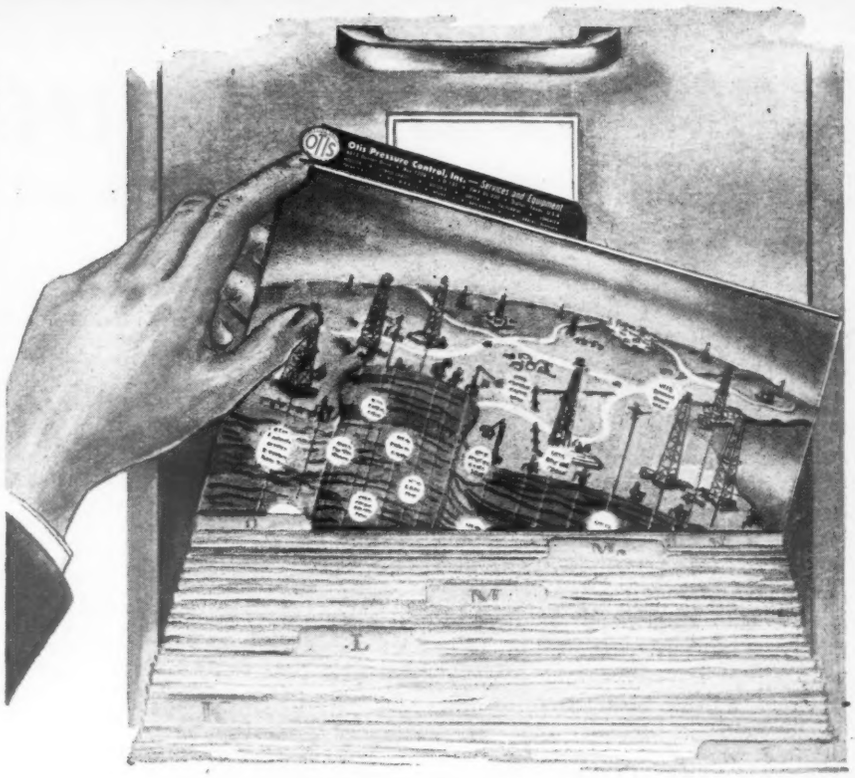
Saudi Arabian Output Up

Crude oil production in Saudi Arabia during March amounted to 19,807,079 bbl, or an average of 638,938 bbl per calendar day, it was announced by the Arabian American Oil Company. This compared with 17,744,102 bbl or an average of 633,718 bbl per calendar day in February.

Crude oil production for the first three months of 1951 amounted to 54,948,420 bbl, an average of 610,538 bbl per calendar day.

Iran Production

Anglo-Iranian Oil Company, Ltd., has produced 2,580,000 long tons of crude oil in Iran during the month of February. Total production for the period January 1 to February 28 amounted to 5,205,000 long tons.



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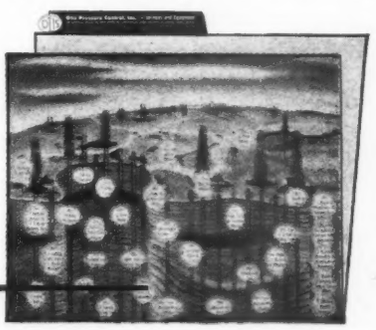

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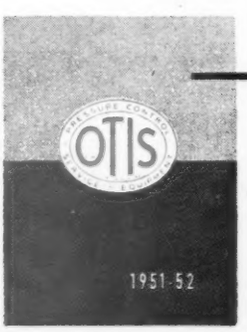

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WHAT'S DOING IN DRILLING

Fayette Field Is Scene Of Gas, Oil Well

Humble Oil and Refining Company has a new discovery in the Fayette field of Jefferson County, Mississippi. The new well is the company's No. 3 A. M. Stewart, which is producing from the Wilcox sand. On initial production tests, the well flowed at the rate of 66.2 bbl of 28.9 gravity oil per day plus 8130 cu ft of gas through ⅛-in. choke. Total depth of the well is 6082 ft, and a string of 7-in. production pipe is cemented at 4050 ft. Previous Wilcox production in the Fayette field has been dry gas.

Well 3½ Feet Deep Pumps 1 Bbl Oil an Hour

A 3½-ft well that flows a barrel an hour has been reported near Colorado City, Texas. In his report of the incident to the Texas Railroad Commission, Joe Greer, district supervisor for the Commission, reported that the producer used an ordinary post-hole digger, dug to 3-ft 6 in. in 30 minutes and struck oil. A small pump brought a barrel an hour of 50 gravity oil.

The exact name of the driller and the location of the site were withheld. Greer reported there is some evidence of oil escaping into the Colorado River near the post-hole site.

Lion Oil Stakes Mississippi Well

Lion Oil Company has staked the No. 2 Denkman, Rankin County, Mississippi, for a 15,000-ft test to the Smackover lime. No. 2 Denkman is 4 miles east of Goshen Springs and a quarter mile from the No. 1 Denkman, which was junked at 13,186 ft. The well is on a 15,000-acre lease block. Southern Production Company has the drilling contract.

New Well in Lindsay Pool

Republic National Gas Company's No. 1-X Harris has been completed in the Lindsay pool of McClain County, Oklahoma. The well has opened a new producing horizon and flows 405 bbl of 45 gravity oil in 18 hours through a ½-in. choke, with gas-oil ratio of 890 to 1, from the Chimney Hill section of the Hunton lime. The well originally was completed early in 1949 with production from the First Bromide sand between 10,800-900 ft.

Rotary rigs operating in oil fields of United States and Canada.*

	Total	Gulf Coast	Pacific Coast	Oklahoma Kansas	Arkansas Louisiana Texas	Rocky Mountain Canada	New Mexico West Texas
Weeks (March)							
Fourth	2351	531	140	454	149	208	825
Weeks (April)							
First	2332	524	140	444	140	207	802
Second	2406	524	146	454	138	229	832
Third	2403	541	157	447	134	215	846

*As reported to American Association of Oilwell Drilling Contractors by Hughes Tool Company.

Alabama Field Gets Two New Producers

The East Gilbertown field of Choctaw County, Alabama, is the scene of two new wells. The Carter Oil Company has completed its No. 4 M. Adams, which is pumping at the rate of 85 bbl of oil and 25 bbl of water per day. Production is from the Eutaw zone where Carter made final perforations with 4 shots at 3337-39 ft. Gravity of oil was 18.9 deg.

The No. 1 Cooper Whigam, on completion test, pumped at the rate of 30 bbl of oil plus a small amount of salt water per day. It is being drilled by Robert Locke. Production is from the Selma chalk zone where the operator perforated with 800 shots at 2454-84 ft.

Papua Well Deepened

From Papua comes a report that Island Exploration Company, Ltd.'s Omati well has been deepened 1599 ft, from 550 ft to 2149 ft. Little can be foretold as to the oil prospects at this depth; however, drilling was reported as being highly satisfactory.

West Texas Producer Drilled by Cities Service

Cities Service Oil Company (Delaware) has given the southeastern corner of the West Seminole field of Gaines County, Texas, another producer in its St. Clair A No. 6. The well was completed for a Railroad Commission potential of 606 bbl of oil daily through ¾-in. choke. Production is through perforations in the San Andrew lime. Total depth is 5142 ft.

Shell Oklahoma Well

Shell Oil Company recently completed a good producer in the Beckham County, Oklahoma, sector of the Elk City field. It is the company's No. 1 Feder "B," plugged back depth to 10,110 ft. The new well flowed 722 bbl of 612 condensate in 24 hours through a 22/64-in. choke with a gas-oil ratio of 4790 to 1.

Wyoming Well Proves High Gravity Producer

A new high gravity producer has been brought in the Wyoming Rockies by General Petroleum Corporation. It is the Green River basin near Big Piney, Wyoming, and about 10 miles from the nearest operating field, La Barge. The wildcat, Tip Top 4x12g, struck oil at 9688 ft. Tests indicate a flow of about 2400 bbl of oil a day, with core samples that indicated the oil could be as high as 50 degree gravity, the company reported.

Sinclair Completes Well In Mississippi County

In Jefferson County, Mississippi, Sinclair Oil and Gas has completed one of the best producers found there in several years. It is the company's No. 1 Liddell. With pipe perforated in the lower Tuscaloosa at 10,071-082 ft, the well flowed at the rate of 265 bbl of condensate and 2,690,000 cu ft of gas a day. Open flow was estimated at 42,600,000 cu ft of gas a day. Shut in bottom hole pressure is 4186 psi.

Shell, Continental Well

Shell Oil Company and Continental Oil Company have completed their No. 2 Soelle "A" in Beckham County, Oklahoma. Flow was 390 bbl of 45.5 gravity oil in 24 hours through a 22/64-in. choke. Plugged back depth is 10,097 ft and gas-oil ratio was 1163 to 1.

UNAFLO*

is proved in the deepest

If you plan to cement—keep this thought in mind: Unaflo was Superior Oil Company's choice for cementing that 19,765-foot string at Pacific Creek No. 1. The job went without a hitch. Unaflo flowed easily and formed a tight seal all the way down that record-depth hole.

On your next cementing job insist on Unaflo three-way protection:

1. EASY PUMPING—Unaflo has high initial fluidity. This makes pumping easier, permits use of heavy slurries when they're needed.

2. RETARDED SET—Unaflo isn't just slow-setting. It stays fluid and pumpable throughout the retardation period, gives you ample time, even in emergencies, to get cement in place.

3. DENSE SEAL—A slurry of Unaflo hardens normally after retardation to form a tight seal and a strong bond resistant to sulfate waters. *To be sure... always protect your investment with Unaflo.*

Send for helpful free bulletin. Shows Unaflo applications, has easy-to-follow tables on various cementing operations. Get your copy of "UNAFLO Oil-Well Cement." Write Universal Atlas Cement Company (United States Steel Corporation Subsidiary), 100 Park Avenue, New York 17, N. Y.

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Thickening time—40% mixing water. Slurry weight: 16.5 lb./gal.

WELL CONDITIONS			Viscosity in Poises at time (Hrs.-Min.) Indicated								Thick. Time Hr.-Mn.
Well Depth (Ft.)	Max. Temp. °F.	Max. Pressure-psi	0	0:15	0:30	1:00	1:30	2:00	3:00	4:00	
6000	113.0	3867	6	8	8	10	10	10	24	77	4:03
8000	125.0	5156	6	7	8	8	8	15	45		3:15
10000	144.0	7484	7	7	6	6	7	8	63		3:03
12000	172.0	10227	11	11	12	12	11	18			2:31
14000	206.0	13386	10	11	11	14	17	20			2:25
16000	248.0	16144	9	9	10	11	19				1:41
18000	300.0	18800	8	8	8	8	47				1:33

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Oklahoma Pool Gets New Field Well

Sinclair Oil and Gas Company has completed a good well, its No. 4 Vaughn as an oil and gas producer in the Southwest Antioch pool of Garvin County, Oklahoma. The new well flowed 264 bbl of 39.6 gravity oil, with 854,000 cu ft of gas, in 9 hours through a 36/64-in. choke from the First Gibson sand through perforations between 7134-58 ft. It also flowed 279 bbl of 69.6 gravity distillate in 9 ft of gas a day, from the Hart sand, through perforations between 7259-78 ft. Plugged back depth is 7290 ft.

Mississippi Field Extended

Production has been added on the north flank of the Eucatta field of Wayne County, Mississippi, at Walter E. Sistrunk and T. F. Hodge's No. 1 Masonite Corporation Unit. On completion tests, the well pumped at the rate of 50 bbl of fluid per day including 25 per cent water. Gravity of oil was listed at 20.8 deg. Production is being obtained through two sets of perforations in the City Bank sand of the Eutaw formation at 5075-84 and 5086-88 ft. Bottomed at 5145 ft, the hole is cased with 5½-in. production casing to total depth.

Gas Field Gets First Oil Well

Magnolia Petroleum Company has completed the first oil well in the South Serepta field of Bossier Parish, Louisiana, at its No. 1 Ansel M. Stroud. On company gage flow was 115 bbl of 48-gravity crude daily through a ⅛-in. choke. Production is from the Ardis sand from 9366 ft to 9375 ft. Gas-oil ratio was 1,700:1. A state potential gage is being awaited. The field now has four gas or distillate wells, one a dual producer.

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Many items of equipment that will save you hours of time and your company thousands of dollars are described in the ads in this issue and in the New Machinery Department beginning on page E-49.

Use the reply card, requiring no postage, to obtain complete details and prices.

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Cadwell Retires After Almost 50 Years' Service

I. T. "Cad" Cadwell, for 25 years drilling superintendent with the Texas Company and for almost 50 years active in practically every oil field in California, retired April 1, 1951.

"Cad," one of the few remaining pioneer cable tool drillers in California, has been closely associated with the progress of the oil industry in that state since it became a major producer at the turn of the century. In those days, methods of drilling were crude, compared to today's engineered processes. The science of geology was practically unknown, and coal oil was the major product.

As a pioneer cable tool driller, Cadwell helped bring in discovery wells in the Orcutt, Los Alamos, Cat Canyon, and Casmalia fields. He drilled the first well for The Texas Company, into the Buckbee zone, during the 1929-30 boom at Santa Fe Springs. Initial production was 5000 bbl per day, between 4900 and 5000 ft. This well was abandoned in 1946. Recently, it was decided to clean out the well down to the top of the cement plug at 3737 ft, whipstock it at that point, and then redrill to 8000 ft. Cadwell, with the ingenuity of an old cable tool driller, supervised the cleanout operation using cable tools of his own design. Then a unique set-up was improvised by Cadwell, whereby the cable tools were operated by a modern pumping unit!

"Cad" Cadwell's many friends in the oil industry wish him the best of luck in his new career.

"What is it?"

"Going to write a book," he says.

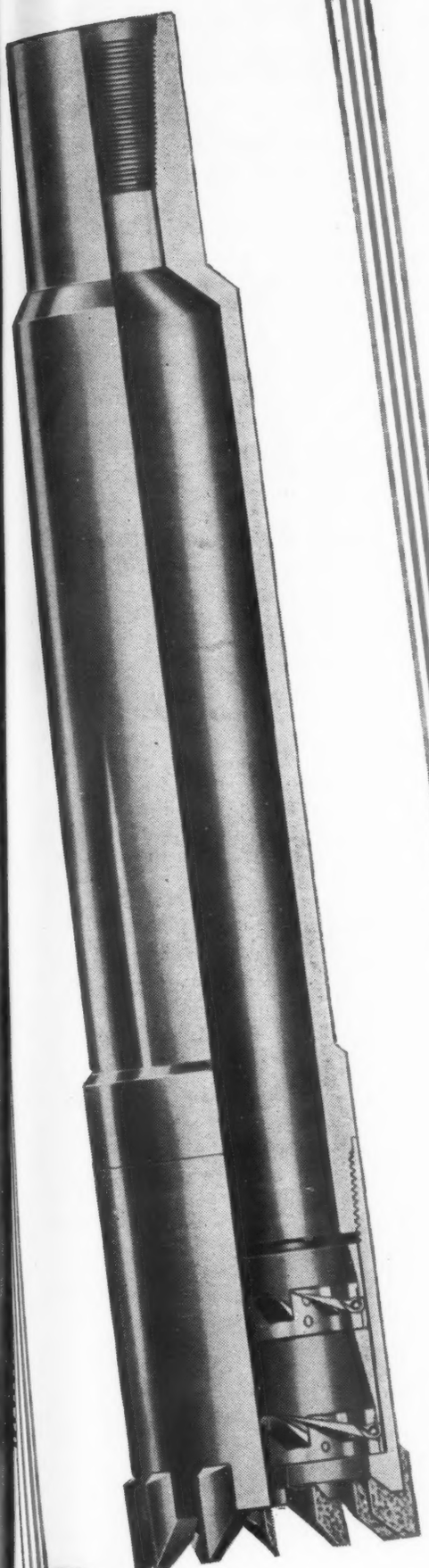
Extends Texas Field

The Texas Company announced the extension of the north flank of Big Hill field, Jefferson County, Texas, with the completion of the Fannie Davis Crow test as a producer.

Situated one and a quarter miles from the nearest production, the well flowed 130 bbl of oil daily through a 9/64-in. choke with a tubing pressure of 475 lb. Corrected gravity was 37.6 and the gas-oil ratio 135 to one. The new horizon in the Miocene was perforated at a depth from 3602-3613 ft.

Mid-Continent Well Drilled In Oklahoma Field

Mid-Continent Petroleum Corporation has added a new producer to the Creek County, Oklahoma, field. It is the company's No. 2 Emma Hill "A", which has been completed for a flow of 60 bbl of oil per day through a ½-in. choke. Production was from the Skinner sand, topped at 2500 ft. Operator set 5½-in. casing at 2502 ft, total depth 2522 ft.



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Positive assurance of complete junk recoveries is making the Globe more popular every day with drillers and toolpushers everywhere!

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EXPLORATION ACTIVITIES

Oklahoma Pool Opener Recovers 390 Ft of Oil

The Carter Oil Company et al No. 1 Garrett is a prospective pool opener for Beckham County, Oklahoma. The new well recovered 390 ft of 40.5 gravity oil, with one per cent fresh water and 90 ft of gas-cut mud, besides gas-cut mud water load, on the drill stem test between 10,285-10,369 ft 8 in. It began coring at 10,432 ft, and is coring at 10,469 ft.

Arkansas Discovery

Miller County, Arkansas, may be the scene of a new discovery. It is Skelly Oil's No. 1 Louis Heilbron, north of the Fouke field. Operator has set 5½-in. casing on bottom at 4281 ft. Skelly cored 8½ ft of sand with oil odor and stain from 3467-77 ft.

Texas Well Drilled

A new oil well has been drilled in northeast Washington County, Texas, by Sinclair Oil and Gas Company. The company reported that 3 drill stem tests described as favorable have been made from 3 horizons in the Wilcox formation at depths of 9216, 9395, and 9440 ft. The latest test was at 9240 to 9440 ft with the well open 15 min, recovery through a ¼-in. bottom hole choke and a ⅛-in. top hole choke amounted to 1200 ft of oil. Gravity was 47.6 deg. The well is drilling ahead and is projected at 10,500 ft.

New Arkansas Field

A new oil field has been opened in Miller County, Arkansas, at the No. 1 Louis Heilbron drilled by Skelly Oil Company. The new well, which is a mile north of the Fouke field, flowed 66.5 bbl of oil in 2 hours through a ¼-in. choke, from what is believed to be basal Paluxy sand at 4180-88 ft. Oil tested 44.6 gravity. Hole was carried to 4281 ft and casing set on bottom.

New Oklahoma Field

A new field has been opened by Shell Oil Company at its No. 1 Tugman, in Stephens County, Oklahoma. The new well found sand at 6073-92 ft, with broken sand at 6092 to 6112 ft. A 1-hour drill stem test at 6078 to 6112 ft flowed oil at the end of 27 min at 20 bbl per hour. Recovered were 360 ft of 40 gravity crude.

U. S. Oil Companies Join Australian Oil Search

The Texas Oil Company and Standard Oil of California are interested in the search for oil in the Exmouth Gulf area of northwestern Australia.

A. P. Long, executive vice president and director of The Texas Company, said in Sydney, Australia, that the two companies would negotiate with an Australian company, Ampol Petroleum, Ltd., for further exploratory work in the northwest. The Australian company holds a concession for the Exmouth Gulf area.

Long added that geologists representing the two companies inspected the area about four months ago and reported that it was well worth investigating. As a result, he and R. J. Follis, chairman of directors of Standard Oil, had included Exmouth Gulf in their round-the-world itinerary.

If the negotiations with Ampol proved satisfactory a team of U. S. oil experts would probably be sent to northwestern Australia, he said. Surface tests made by Australian scientists in the northwest country of Western Australia during the past three years have indicated that further research for oil is fully justified.

A party of geophysicists of the Bureau of Mineral Resources will leave for the northwest to make further geophysical tests. The party will carry seismograph equipment and will remain in the area for about eight months.

Kuwait Test Drilling Below 12,240 Ft

Kuwait Oil Company, Ltd.'s deep test in Burghan field has been reported below 12,240 ft. The well now has 3000 ft of open hole, and 5-in. casing is expected to be run in the near future. It may be taken to possibly another 1000 ft to reach total depth before testing.

New Canadian Discovery

A new discovery has been reported in Saskatchewan, Canada, by Albercan Oil Corporation. Tests indicate an open flow potential of approximately 12,000,000 cu ft a day. Stuart P. King, president of Albercan, said the company at present intends to use the gas for gas-lifting operations in its Lone Rock heavy oil field, which underlies the gas reservoir.

Kansas Well Recovers 496 Ft of Oil in 10 Min

Recovery of 496 ft of oil and no water in a 10-minute drill stem test has been reported in a Finney County, Kansas, wildcat by W. L. Hartman, Wichita operator. The well, No. 1 Damme, is six miles from the nearest production in the Nunn field. Test was at 4417-30 ft, and believed to be in or near the Altamont lime, producing horizon in the Nunn field. The well is being drilled to test deeper formations including the Mississippian, expected at about 5000 ft.

Texas Well Successful

The completion of its Hastedt No. 1 well in Colorado County, Texas, was reported by Cities Service Oil Company (Delaware). The well was finaled for a calculated open flow of 7,400,000 cu ft of gas daily, 45 bbl of distillate per 1,000,000 cu ft of gas, through tubing perforations from 9602 to 9607 and from 9632 to 9637 ft, and a calculated open flow of 5,000,000 cu ft of gas daily, 40 bbl of distillate per 1,000,000 cu ft of gas, through casing perforations from 8745 to 8750 ft.

Magnolia Has New Well In New Mexico County

Magnolia Petroleum Company has a new oil discovery in southeastern Roosevelt County, New Mexico, at its No. 1 J. B. Brown well. On drill stem test of the Pennsylvanian sand from 8088 to 8142 ft, the well flowed 112 bbl of 45 gravity oil into the tanks in 2 hours, with gas flow of 1,500,000 cu ft daily. Recovery was circulated out of the drill stem and casing was being cemented at an undisclosed point for completion.

B-A Discovery in Colorado

The British-American Oil Producing Company, wholly-owned B-A subsidiary in the United States, has announced another new discovery well in Logan County, Colorado. The report states that the well, Monroe No. 1, swabbed 113 bbl of clean oil in 14 hours or an 8-bbl per hour rate. The well is presently at a depth of 4890 ft and B-A is now preparing to install pumping equipment. This latest wildcat is situated about five miles south and east from the Cheairs and Yenter production.

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Indiana Well Flows 40 Bbl of Oil an Hour

In Clinton County, Indiana, the E. J. Goldschmidt, et al, No. 1 Jaske is flowing 40 bbl of oil an hour from the Silurian limestone at 2264 to 2280 ft. Total depth is 2280 ft. The well was acidized with 1000 gal of acid and has been choked down for lack of tank room.

India Test Made

Assam Oil Company, Ltd. is continuing its exploratory program in eastern India with preparations for a new test well at Nichuguard in the Naga Hills jungle of Assam. The Burmah Oil Company Ltd., subsidiary, hopes to begin drilling soon.

Texas Wildcat Drilled

Cities Service Oil Company of Bartlesville, Oklahoma, has announced a wildcat in the northwest corner of Howard County, Texas. The well is Adams No. 1. Main objectives of the 9700-ft test are the Pennsylvanian Canyon and Strawn reef limestones. The test is 7½ miles southwest of the Vealmoor field, which produces from the canyon reef. It is situated on an 800-acre unit jointly held by Cities Service, Lion Oil Company, and Warren Oil Corporation.

Kentucky Well Testing

The Simon Lebow No. 1 Mosely in Daviess County, Kentucky, is testing the Tar Springs sand at 946 to 964 ft. A shot of 60 quarts of nitro was used and 85 bbl of oil were pumped on beam in 8 hours.

North Dakota Gets First Commercial Oil

The first commercial oil production in North Dakota has been brought in by Amerada Petroleum Corporation in Williams County. Latest gage on the well, No. 1 Iverson, was a flow of 159 bbl of 53 to 55 gravity oil in 13 hours through a ¾-in. choke, with about 5,000,000 to 6,000,000 cu ft of gas a day. Bottomed at 11,744 ft the well is producing from perforations between 11,630-60 ft from a limestone which is believed to be the Devonian, the main producing horizon in the oil fields of the province of Alberta in Western Canada.

New Mexico Well Tested

Tide Water Associated Oil Company has completed the testing of a new discovery near Lovington, Lea County, New Mexico. The well tested 1056 bbl of 41 gravity oil from Pennsylvanian Lime, the pay zone being from 11,040 to 11,180 ft, 40 ft of which was perforated.

Mississippi Wildcat Well Is New Wilcox Discovery

A new Wilcox reservoir discovery is assured for Wilkinson County, Mississippi. Jon Brooks and Petersen Drilling Company et al are drilling a well, which on early tests, has flowed at the rate of about 175 bbl of oil per day through 11/64-in. choke. Flowing tubing pressure rose to 75 lb. Well is now being shut-in while storage tanks are being erected on location. Hole has been bottomed at 8461 ft.

Sulfur Rights Obtained at Nash Dome, Texas

Freeport Sulphur Company has obtained the sulfur rights on a prospect at Nash Dome in Texas and will begin exploration drilling there in the near future, Langbourne M. Williams, Jr., president, announced.

Nash Dome, situated about 35 miles southwest of Houston, is the sixth Gulf Coast salt dome at which Freeport is now undertaking to find and develop sulfur. The company recently announced plans to prospect four domes in Louisiana and to build a sulfur-mining plant at another dome in that state.

The Nash prospect is known as the Belle Wisdom acreage. The agreement signed by Freeport was with the Houston Bank and Trust Company, executor and trustee of the Belle Wisdom estate. The principal beneficiary of the trust is the Kentucky Female Orphan School near Lexington, Kentucky. The dome has been partially explored previously but additional drilling will be necessary to determine whether sulfur exists in commercial quantities, Williams said.

Deep Wildcat Set

The location of a deep wildcat in Grady County, Oklahoma, has been announced by Cities Service Oil Company (Delaware). The 12,000-ft test is Amberg No. 1. Ownership of the block is between Cities Service, Phillips, Magnolia, Skelly, and Gulf. Cities Service will be the operator. The wildcat will be drilled to the Bromide sands, testing these sands, other Pennsylvanian sands and the Hunton lime.

Ecuador Wells Planned

Two new wells are being planned for Ecuador by the Manabi Exploration Company, which recently purchased the properties of Ecuador Oilfields Ltd. The new wells, the El Tigre 44 and 45, will be drilled to the Atlanta sands, and also a third one will be carried 1000 ft deep to study the underlying formation.

Wet Gas Discovery

Wet gas production has been indicated at a wildcat in Harrison County, Texas, at the A. Z. Skeeters No. 1 W. T. Cook. The well was reaming down to set 5½-in. pipe after running a test at 6700-800 in the lower Pettit. Though flow was ungaged, operator estimated gas production between 30,000,000 and 50,000,000 cu ft of gas daily plus 80 bbl of dark colored distillate per 1,000,000 cu ft.

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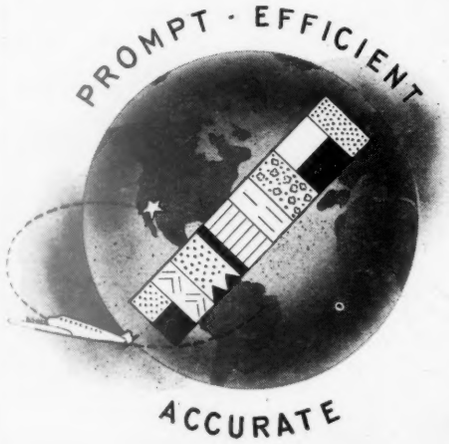

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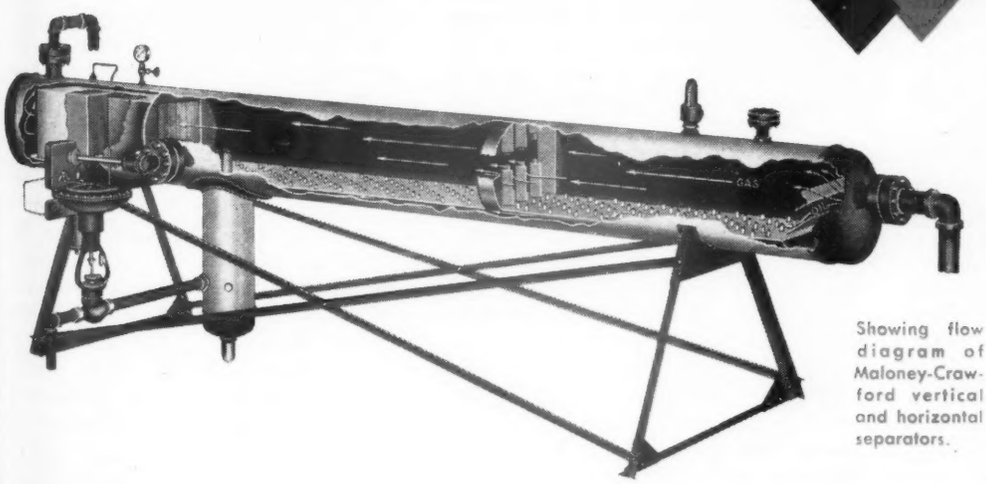

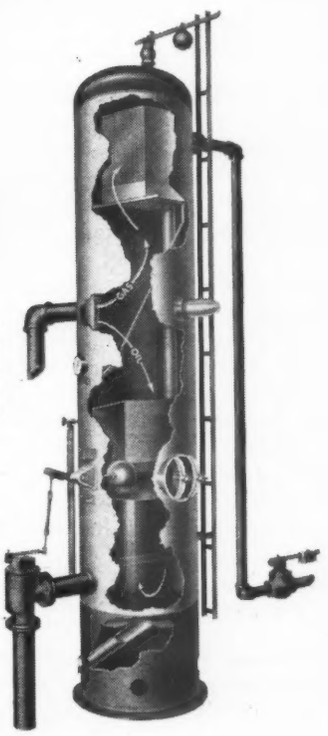

Showing flow diagram of Maloney-Crawford vertical and horizontal separators.

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NORTH TEXAS OIL AND GAS ASSOCIATION OFFICERS FOR 1951

M. E. McCullough Fred Sehmann E. B. Clark C. N. Prothro

▸ **M. E. McCullough** has been elected president of the North Texas Oil and Gas Association, Wichita Falls, Texas. Other newly elected officers are: **E. B. Clark,** 1st vice president; **Charles N. Prothro,** 2nd vice president, re-elected, and **Fred Sehmann,** executive vice president, re-elected. The Association held its 21st annual meeting recently, at which approximately 1000 members attended.

▸ **Reese H. Tucker,** chief geologist for Cities Service Oil Company (Delaware), Bartlesville, Oklahoma, has been appointed manager of the land-geological division. Tucker succeeds **Robert L. Kidd,** who was recently appointed assistant to the president. Tucker was first employed by Cities Service in 1930 as a junior engineer. His permanent assignment was in the geological division. He advanced steadily and, in 1948, was appointed manager of the geophysical department. The next year, he was named chief geologist for the company.

▸ **O. I. Torkelsen** has been promoted to the newly-created position of exploration and production co-ordinator of The British American Oil Company Limited. Torkelsen's headquarters are in Toronto, Ontario.

A graduate of the University of California, Torkelsen joined British American 12 years ago as field geologist. In 1946 he was made a vice president of the producing company in charge of all production activities in the western division and in 1948 was promoted to manager of the western division covering exploration and land acquisition as well as previous responsibilities. He has held this latter position until his current appointment as exploration and production co-ordinator.

▸ **Harvey Cash Jr.,** assistant to division manager, has been advanced to assistant division manager, producing department, The Texas Company. He is being succeeded as assistant to division manager by **J. A. Bermingham Jr.,** division petroleum engineer. **C. F. Elder,** assistant division petroleum engineer, is being moved up to division petroleum engineer. All three men are in the Oklahoma division headquarters, Tulsa, Oklahoma.

Cash, a native of Dimmit, Texas, was graduated from Texas A. and M. College with the B.S. degree in electrical engineering in 1933. Shortly afterward, he began with the company in the geophysical division at Houston.

Bermingham was graduated from the University of Southern California in 1934 with the M.S. degree in petroleum engineering. He began with The Texas Company as assistant petroleum engineer in Los Angeles Basin.

A native of Cameron, Missouri, Elder was graduated from the University of Oklahoma with the B.S. degree in petroleum engineering in 1940. He joined The Texas Company as a laborer in the Illinois District in 1940.

▸ **James F. Ormond,** production department field engineer for Sunray Oil Corporation, Midland, Texas, has been awarded the National Safety Council's president's medal for acting in a recent emergency, which probably saved the life of a Sunray employee. Ormond will be awarded the medal by the Medal Administration Committee of the Council for successfully applying artificial respiration to a fellow workman, Kenneth D. Mullings, who inadvertently came in contact with an electrical wire carrying 12,700 volts of electricity, while working on a West Texas lease near Odessa.

▸ **Lennox A. Fitch** has accepted the position of assistant manager of Land Department of the Pan-Am Southern Corporation and will be situated in the company offices at Shreveport, Louisiana, according to announcement made today by M. C. Hoffman, vice president of Pan-Am. Fitch has recently resigned his position of South Louisiana District Landman with the Sohio Petroleum Company at Lafayette, Louisiana. Fitch is a veteran landman well known in the Mid-Continent and Gulf Coastal Areas. For the past five years he has been with the Sohio Petroleum Company. He is a graduate of Schreiner Institute.

▸ **T. C. Stauffer,** Evansville, Indiana, manager of Sun Oil Company's central production division, has been elected chairman of the Illinois Basin chapter of the API. **Jack Runnels,** retired Sun Oil Company employee at Nederland, Texas, died at his home on February 16. He had been with Sun since 1930, and retired in December, 1949.

F. C. Asher, Sun Oil foreman, Snyder, Texas, died on February 1. The 21-year Sun veteran joined the company as a gang pusher-pumper in McCamey, Texas, in 1929. His brother, E. A., is with Sun in the Odessa area, Texas. **John P. Bassett,** Sun Oil Company departmental supervisor in the Evansville, Indiana, office, has been elected secretary and treasurer of the Illinois Basin chapter of the API.

R. E. Dobkins has been transferred to Morganfield, Kentucky, as assistant superintendent of production for that Sun Oil district. He formerly was a foreman in the Phillipstown, Illinois, district.

▸ **Robert L. Kidd,** vice president and manager of the land and geological division of Cities Service Oil Company, Bartlesville, Oklahoma, has been appointed assistant to the president. In addition to his new duties, Kidd will continue to work on oil exploration and development.

Kidd, who is also a director of the company, has been with Cities Service more than 25 years. He served as development geologist at Madison, Kansas, resident geologist at Oil Hill, Kansas, chief geophysicist, assistant chief geologist, and chief geologist at Bartlesville, Okla. In 1945 he was promoted to the position of manager of the land and geological division and three years later was elected a vice president of the company. Kidd was graduated from the University of Indiana with a major in geology.

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Quickly Tells Exactly WHERE Pipe is Stuck, Eliminates or Simplifies Fishing, Saves Time, Money, and Pipe

A **PROGRESSIVE TOOL** is a tool that permits a **FAST** return to normal PROGRESS in an oil well. Included in the 20 McCullough services are 6 progressive tools. The KEY tool in this group is the Magna-Tector. It is called the KEY tool because it unlocks the secret of exactly WHERE pipe is stuck, and opens the way for other progressive tools to complete the job in minutes.

Save Pipe, Time, and Money—Call for the Magna-Tector FIRST!

When casing, tubing, or drill pipe becomes stuck, considerable savings can be realized by calling for the Magna-Tector at once. This has been proven in thousands of wells. Estimating the stuck point, cutting the pipe, and then finding that the estimate was wrong is a costly method. Unnecessary cuts must be paid for, rig time is multiplied, and fishing usually becomes complicated.

By calling for the Magna-Tector at once, the danger of pipe sticking further up the hole is minimized. The exact stuck point is located within inches, in minutes. The number of shots or cuts required to recover all free pipe is reduced. More free pipe is recovered in ONE piece. The way is paved for other fast, McCullough electric wire line progressive tools (McCullough Jet Back-Off Tool, String Shot, or Jet Casing Cutter) to free all free pipe, making recovery of the remaining stuck sections routine.

Drill pipe is the most common stuck pipe condition. When drill pipe becomes stuck, it is usually assumed that the drill collars are stuck. Spotting oil around the drill collars, without first calling for the Magna-Tector, has proven to be false economy. In many instances, after oil had been spotted around the drill collars without results, the Magna-Tector was called upon. The stuck point was found to be several hundred feet above the drill collars. When the oil was moved up to the EXACT stuck point, the pipe was freed in only a few hours time. MORAL: Guesswork is a poor substitute for KNOWING, always use the Magna-Tector FIRST!

Not a Fishing Tool

The Magna-Tector is NOT a fishing tool. Fishing means probing with unseeing eyes. The Magna-Tector has eyes at the surface. These eyes, in the form of electronic meters, tell the McCullough serviceman what he needs to know about the condition of the pipe in the well. In some cases the Magna-Tector eliminates the need of fishing tools. In other cases it simplifies recovery by reducing the number of shots or cuts usually needed.

How the Magna-Tector Locates the Stuck Point

The Magna-Tector is an electronic tool. It is unaffected by high hydrostatic pressure or high temperature. It has been successful on over 5,000 jobs. In the world's deepest well, the Magna-Tector located the stuck point in the drill pipe below 16,000 feet!

In operation, the Magna-Tector is lowerd inside of the stuck drill pipe, casing, tubing, or liner on an electric wire line. It is positioned at a predetermined depth for testing. Electric current is then turned on, energizing two electro-magnets at each end of the tool. This strong magnetic force holds the Magna-Tector, firmly, against the pipe. Tension is applied to the pipe at the surface. Any movement of the pipe between the two electro-magnets, as detected by electronic surface meters, indicates free pipe. Lack of movement indicates stuck pipe. By progressing up or down, the EXACT stuck point can be located within inches!

An Additional Service—Determining the Sticking Medium

The value of the Magna-Tector is two-fold. In many cases it can actually determine the sticking medium. It can indicate such conditions as: collapsed pipe; frictionally held pipe; bridging; and key seat conditions. In tubing it can determine whether the tubing is stuck above or below a packer or tubing hanger. With such additional knowledge, freeing and recovery of all pipe is greatly simplified.

Where drill pipe is frictionally held by mud, sand, or other impacted material, working and circulation sometimes results in freeing the pipe deeper in the well. In one outstanding instance, where this procedure was used, the pipe was freed 1,800 feet BELOW the original sticking point!

Cominbation Progressive Service—Another Way to Save Time

The set-up used by the Magna-Tector is the same set-up as used by any McCullough electric wire line progressive tool. Since the set-up at the well is already made, it's a simple matter to attach a McCullough Jet Back-Off Tool, String Shot, or Jet Casing Cutter to the end of the same electric wire line, after the Magna-Tector has located the stuck point. Therefore, many operators, when ordering Magna-Tector service, also order the type of progressive tool they will need to complete the job. Rig time is saved and combination service charges apply, resulting in additional savings.

Write for this Catalog

The new McCullough section of the Composite Catalog is now off the press. All 20 McCullough tools and services are included in this catalog. Illustrations, operating data, construction, and specifications. Pages 3228 and 3229 describe the Magna-Tector and its applications, with appropriate photographs and illustrations. Write to the McCullough Tool Company for your copy.

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To obtain more information on products advertised see page E-49

E. V. McCollum

Craig Ferris

E. V. McCollum and **Craig Ferris,** geophysicists and exploration experts, have formed the GeoSeis, Inc., at Tulsa, Oklahoma. They are now associated with E. V. McCollum and Company, which firm will be closely associated with the new company. Their service in the field of seismographic prospecting will cover the United States and Canada. Field crews are already working in some areas. McCollum got his M.S. degree in 1926 from the University of Oklahoma and was with Marland Oil Company until 1929. In 1943, he formed the E. V. McCollum and Company of Tulsa, gravity and magnetic contractors. Ferris got his A.B. degree at Friends University at Wichita in 1934, and did graduate work at the University of Oklahoma in 1935-6. He was with Mott-Smith Corporation from 1938 until he joined McCollum in 1943.

Stephen R. McGavran has been appointed production engineer for the San Joaquin division of the General Petroleum Corporation's production department. McGavran has been with General Petroleum since June, 1948, having joined the company's production department as a well puller immediately following his graduation from the University of Southern California in engineering.

Murray J. Wells of Bartlesville, Oklahoma, has been named division geologist for Cities Service Oil Company (Delaware) in the Northern Rocky Mountain division, according to an anouncement by R. H. Tucker, chief geologist. Division headquarters are in Casper, Wyoming. Wells steps up to the new position from the post of regional geologist for the Oklahoma and North Texas districts in the Bartlesville office. He will be succeeded by **Paul H. Hyatt,** formerly a member of the Cities Service geological staff at Oklahoma City. **T. C. Hiestand** will serve as regional staff geologist in the Northern Rocky Mountain division office at Casper.

Wells joined the Oklahoma City staff in January of 1936. After serving four years there, he was transferred to the Bartlesville headquarters office in 1940. In 1943, he was named division geologist for the Oklahoma and North Texas districts. He is a graduate of Oklahoma University in geology. Paul Hyatt was employed by Cities Service in August of 1946 at Oklahoma City. He, too, holds a B.S. degree in geology from the University of Oklahoma. He was transferred to Bartlesville in February of this year.

Dr. Sigmund Hammer, Gulf Research and Development Company, Pittsburgh, Pennsylvania, has been elected president of the Society of Exploration Geophysicists at the society's annual election. Dr. Hammer served as vice president of the society during the past year. **Curtis H. Johnson,** General Petroleum, Los Angeles, was elected vice president, and **R. C. Dunlap, Jr.,** Geophysical Service, Dallas, was chosen secretary-treasurer. **Paul L. Lyons,** Carter Oil, Tulsa, was elected editor of *Geophysics,* the society's journal, for a period of two years. Outgoing secretary-treasurer is **Francis F. Campbell,** Amerada Petroleum, and outgoing editor is **Richard A. Geyer,** Humble Oil and Refining. **Colin C. Campbell,** of Tulsa, continues as business manager of the society.

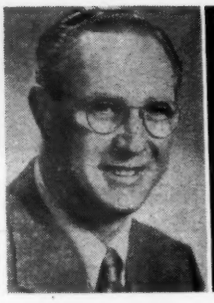
Miller W. Quarles, Jr., district supervisor for the United Geophysical Company, Houston, Texas, received the annual award of the Society of Exploration Geophysicists for the best paper on geophysics in 1950. The presentation was made at the national convention of the society. The paper, "Fault Interpretation in Southwest Texas", was published in the July 1950 issue of *Geophysics,* the society's quarterly journal. The article deals with seismic studies used in the exploration for oil trapped against sedimentary faults.

Honorable mention went to **Dr. George P. Woollard** of the department of geology at the University of Wisconsin for his paper, "The Gravity Meter as a Geodetic Instrument", which appeared in the January 1950 issue of *Geophysics.*

Gus A. Standish has been promoted from petroleum engineer in Magnolia Petroleum Company's Lake Charles district to petroleum engineer in the Gulf Coast division offices at Houston.

Clarence Wells, Jr., petroleum engineering assistant located formerly at Shreveport, has been transferred to the Kermit district.

Dee F. Pendley, Jr., who has been a petroleum engineer in the Electra District, has been transferred to the Kermit Producing District. He will be at Midland, Texas.



J. W. Anderson

C. R. Powers

James W. Anderson was named vice president, sales and **C. Robert Powers** vice president, manufacturing, of Whitney Chain Company. The appointments were made at the annual meeting of the board of directors of the company. Anderson joined Whitney Chain 1938, after 10 years of diversified activity in the power transmission industry. He was appointed general sales manager of the company in 1948. Powers was formerly consultant to the president on all phases of Whitney manufacturing activities. Prior to joining Whitney, he was associated with the Dearborn Motor Corporation of Detroit, Michigan.

Forrest E. Wimbish has been promoted to district geologist in charge of Magnolia Petroleum Company's Kansas district with headquarters in Wichita, Kansas. **Kenneth R. Joynt** has been transferred from assistant district superintendent of Magnolia Petroleum Company's Lake Charles producing district to the Vanderbilt district.

O. B. Jordan has been transferred from assistant district superintendent of Magnolia's Brownfield district to the company's Lake Charles district.

John R. Hissom has been transferred from assistant district superintendent of Magnolia's Healdton producing district to the company's Brownfield district.

William C. Dougherty has been promoted from assistant foreman in Magnolia's Kermit producing district to production foreman in the same district.

C. P. Latting, production foreman in Magnolia's Salem, Illinois producing district, has been transferred to the Rusk producing district with headquarters at Kilgore, Texas.

Barney C. McCasland, Jr., has been appointed district geologist for Cities Service Oil Co. at Olney, Ill. McCasland has been with Cities Service and affiliates since 1941 and is a graduate of Texas Tech at Lubbock. For the past 4½ years, he has been on the Cities Service Oil Company geological staff at Jackson, Mississippi.

THE TURNAROUND

Refining Capacity Expansion Mandatory

A MILLION BARRELS DAILY of additional refining capacity, within the continental boundaries of the United States is mandatory, says PAD deputy chief Bruce Brown. Without this tremendous boost to our finished products output we cannot hope to meet the demands of the defense program and at the same time keep up the economy of the country in general.

Military demands for petroleum products during the last half of 1951 are expected to increase 20 per cent over the first half, says Reid Brazell, PAD refining division head. Of this increase, military aviation fuel demand will rise 30 to 35 per cent, jet fuels 20 to 30 per cent. Each of these leaders urges refiners everywhere to plan expansion of their basic facilities for refining crude, to do so with their companies' own monies, and exempt tax money from any part of this program.

During the five years since VJ Day our daily rated refining capacity increase has averaged 300,000 bbl per year, or 1,500,000 bbl for the period. To this must be added the above-mentioned capacity or by 1953 the public may be faced with shortages as onerous and as throttling to our private enterprise economy as the actual impact of war. Nor do these capacity figures include that which will be indispensable in case we go actually into an all-out major war. Preparations for defense and the program now being carried out for national defense by the petroleum and other industries require that our basic refining capacity must be brought up-to-date before we can hope to put our house in order.

This expression "basic refining capacity" is defined as meaning the making of typical peacetime products of fuel oils, gasoline, kerosine, asphalts, lubricants, waxes, etc. The special military units and processes are dependent on this basic capacity for their raw materials and intermediate streams from which the finished products are made.

To the small refiner the industry and the country must look for a large part of this increase in basic capacity, Brazell indicates. This is possible because of the important reduction in the cost of catalytic cracking and alkylation units. Cat crackers have been brought within the purse capacity of small refiners because of new and improved design, and by the omission of certain "gold plating" and auxiliary accessories that were thought earlier to be indispensable to these processes. It is believed that alkylation processes are undergoing the same sort of improvement and cost reduction, so that small refiners too can operate them, peacetime, at a profit to meet the nation's demands.

Significant indeed is the position taken that if and as far as possible the refining industry should build this additional capacity as private enterprise with its own money, without using taxpayers' funds; the foregoing will insure "usual business prudence" being used in carrying out the expansion. Higher income taxes levied on industry because of the needs of the defense program, however, might reduce drastically the hope of the industry's obtaining enough net tax-free revenue to recoup the costs on a normal pay-out basis. PAD has recommended that pay-out periods be extended from up to 12 years to a 5-year period as permitted under the law. Other relaxations have been recommended in the matter of credits to aid refiners in carrying out these expansion programs.—A.L.F.

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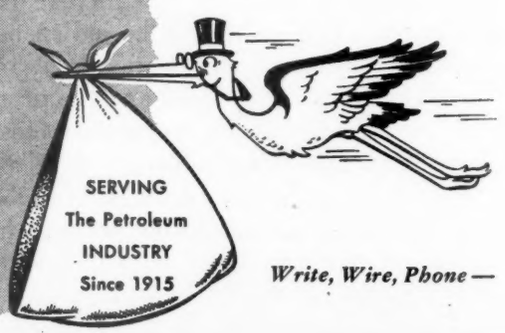

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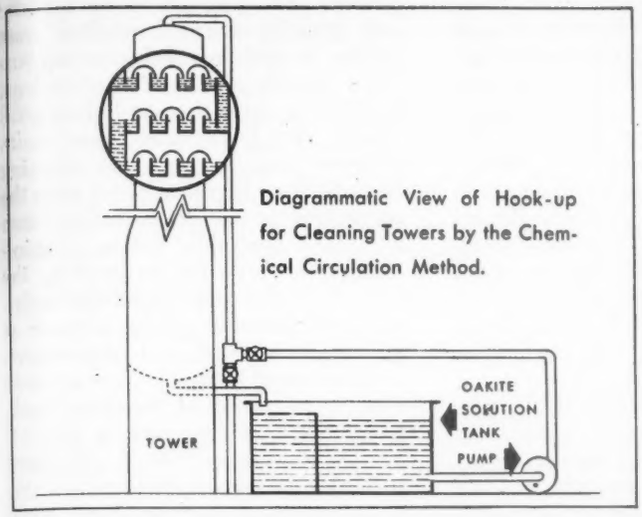
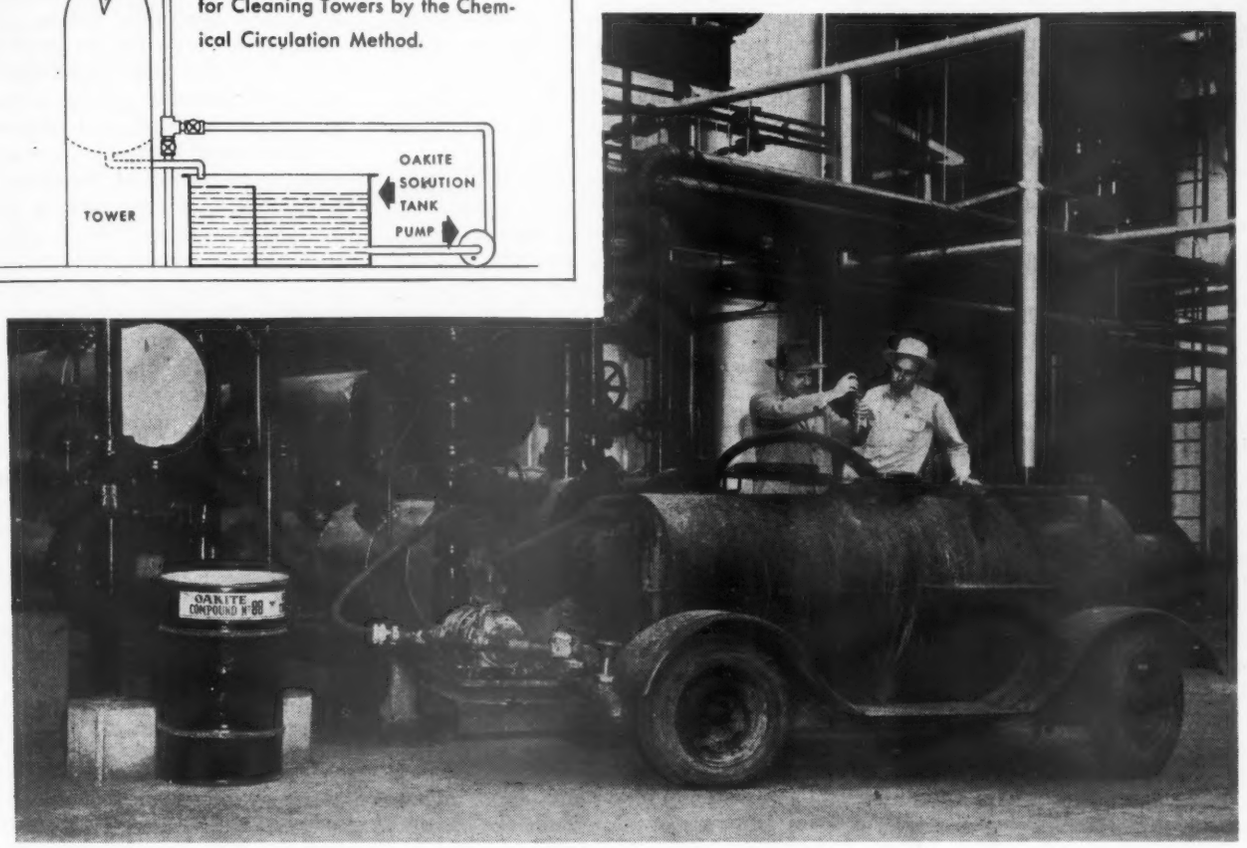


Diagrammatic View of Hook-up for Cleaning Towers by the Chemical Circulation Method.

FIG. 1. Permanent installation for tower cleaning, showing how circulation can be simply achieved by piping into existing lines.

FIG. 2. Mobile equipment like this for circulation cleaning can be fabricated by refinery personnel and easily operated by them to provide effective chemical tower cleaning.



Chemical Circulation Cleaning of Towers

How to simplify and reduce cost of cleaning vessels by using proper chemicals and equipment, efficient procedure.

VINCENT E. BOWES*

REFINERY processing towers work best when they are clean. But achieving this end is one of the most discussed, and sometimes cussed, problems refinery men have to deal with. Scheduling men, equipment, and materials to handle that work must be arranged into a smooth flowing procedure so that the fastest possible turnaround is obtained for towers. The facts that certain towers need cleaning more often than others, because of the different crudes being run and because of the different processes in which they are engaged, complicate the picture further. Some towers need frequent cleaning and others in different processing cycles are self-cleansing. In all, a good deal of planning must go into the schedule to provide for regular chemical cleaning of towers when and where it is needed. It pays off because chemical cleaning is a proved way of getting towers back on stream faster and restoring them to their designed efficiency.

There have been many different ways devised for tower cleaning, ranging from fast to slow, from efficient to poor. Certain methods prove to be far too expensive in material and service costs. It is being shown day after day that of the different ways to clean towers, the manual method is not always practical either. As many refiners know too well,

*Manager, Petroleum Service Division, Oakite Products, Inc., 22 Thames Street, New York 6, N. Y.

EXCLUSIVE

manual cleaning can keep towers off stream a costly long time. There are few instances when sandblasting and chiphammering methods, if effective, prove to be anything but laborious and time-consuming. Even when the towers are designed to permit men to enter them and clean the fouled trays, caps, downcomers and other interior surfaces—the time required often runs out of proportion to the results, and the cleaning costs increase beyond practical limits. Besides that the non-productive time of towers off stream for cleaning becomes a costly item. But with chemical-circulation method refiners learn that the complete cost of cleaning, handled by the refiner's own work crew, is often half that of other methods of tower cleaning. And, equally important, the tower gets back on stream far faster.

Today's definite trend in favor of cleaning towers by the chemical circulation method is easily traced to its over-all economy and the fact that the refiner can handle the entire job with his own equipment, operated and supervised by refinery personnel. Another reason behind the trend is that manufacturers of chemical detergents have devised and made available simplified and highly workable methods of doing this work. The strides made by these manufacturers, their laboratory staffs and their technical service representatives have spelled the difference between expensive and economical tower cleaning for many refineries and gas absorption plants. By using the chemical detergents specially designed by these manufacturers and by applying the freely available expert advice they offer, it is now possible to set up procedures that provide effective, economical tower cleaning.

Widely Used

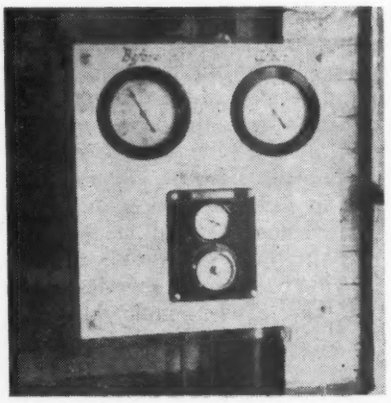
There are many reports of successful and economical cleaning using the chemical circulation method. One refiner figured out the costs of chemical as compared to mechanical methods of cleaning a combination unit stablizer tower. It took him 39 hours for the complete job and, after close inspection, found that the tower was very clean even around the bubble caps. Even with temporary circulation equipment, which ran his costs a little higher, he reports that the round figure costs of chemical circulation cleaning was $600 as compared to $1200 for mechanical cleaning.

Another refiner cleaning absorption towers and exchangers praises one of the big advantages by commenting on how chemical circulation cleaning helps him put his equipment back on stream faster at a higher efficiency rating than ever before. And it costs him far less than previous methods. His particular problem was the removal of acid aldehyde, which resulted from the contact between acetone and formaldehyde in the towers and exchangers. He set up the simplified equipment necessary to circulate a specialized chemical detergent through both the towers and exchangers. Results: Good cleaning action and complete, thorough removal of soils.

Another example of good cleaning action by the chemical circulation method comes from a natural gasoline plant where the operator reports that he effectively and economically removed scale and rust from a 54 ft 6 in. by 30 in. diam., 30-tray debutanizer. He circulated a chemical cleaning solution through the tower for 4 hours and thoroughly dissolved and removed the scale and rust. Another hour, half for neutralizing and half for rinsing, completed the procedure. This tower was quickly returned to maximum efficiency at minimum cost; and now he is sold on the idea of cleaning by chemical circulation.

Basically the chemical-circulation method involves the use of a chemical cleaning solution that is circulated from the solution containing tank to the top of the tower, across the trays, bubble caps, and other interior surfaces, and back to the solution tank. The fouling, residual material that has accumulated on these surfaces is removed chemically with the help of the physical action of the circulation. This cleaning is not only fast—records show time savings up to 75 per cent—but also very effective. Surfaces are left really clean so that future build-up is retarded; thereby deferring future cleaning.

FIG. 3. Emulsifying valve panel board.



Besides that, circulation of a chemical cleaning solution reaches areas hidden to cleaning tools, leaving surfaces smooth and free of abrasions. It not only saves time and gives good results, but it requires fewer maintenance men because the cleaning work is done chemically. So once the procedure is set in operation, men are freed for other duties. A minimum crew may be assigned to the job of checking the pumping activities and maintaining the solution at the proper strength and temperature.

Circulation cleaning can be done with a permanently installed tank, pump and connections (see Fig. 1), or with the same type of equipment mounted on wheels for transporting it to any unit that needs cleaning, (see Fig. 2). This equipment can be easily hooked into existing product-carrying lines of the tower. The technical service representatives of the manufacturers provide expert advice to help in the fabrication of this equipment as well as providing the information to help refineries set up chemical circulation procedures.

Soil Analysis

This expert advice is especially helpful in the selection of the cleaning material best suited for the work. To do this, a working knowledge of the kind of soil is very important.

Visual and in many cases, chemical examination of deposits that have formed on processing equipment surfaces will help to determine the selection of the proper chemical for circulation cleaning. The characteristics of these fouling substances, their thickness and adhesive properties will also go a long way toward determining the temperature and pressure at which circulation-cleaning is to be performed. Good practice shows that controlled tests should be undertaken to determine the solubility of particular deposits in various chemical solutions, until selection of the proper compound or compounds is made. This will save time experimenting to find the right material under actual operating conditions. While deposits vary from one processing cycle to another, basic experience in performing a wide variety of similar tests on refinery equipment is both important and extremely helpful. For these tests, it is well to select sample deposits from different points in the tower.

The importance of such testing is emphasized because the efficiency of the cleaning operation is immeasurably stepped up if tests on a small scale can be performed before setting out on the procedure. Regarding tests, it can be said generally that if sweet

crudes are being run, greasy and waxy soils have contaminated the surfaces to be cleaned. That particular soil is effectively removed by a different kind of detergent than one needed to remove accumulations that build up when sour crudes are being processed. Sour crudes leave in their wake deposits of grity or flaky scale make-up.

Chemical Cleaner to Use

The success of cleaning towers by the circulation method usually hinges on one very important factor: Chemically breaking the binder that holds the soils to the tower surfaces. Therein lies the opportunity of making the big savings which circulation cleaning offers. Finding the most efficient material for this work completely simplifies the job. But, taking a chance of hitting on the right material without being prepared with workable information is often worse than no cleaning at all. It is possible that an error on the choice of the method of the chemical cleaning material can lengthen tower turnaround time considerably. That is why refinery maintenance men would do well to give adequate consideration to the selection of the right chemical materials and proved methods.

Experience with circulation cleaning procedures indicates that if the soil binder with a high oil content, which holds tower fouling deposits to the metal surface, can be loosened quickly, the job of cleaning is greatly expedited. For this primary binder-breaking task, a fast-emulsifying material is usually recommended. Such a commercially produced chemical material will solubilize deposits like waxes, resinous products, and entrained sweet crude formations. This chemical, when circulated under proper controls, lifts off the deposits and suspends them in the cleaning solution as it is circulated through the tower and chemically changes the residues to permit quick, easy rinsing for complete removal.

Usually a different type of specialized chemical compound is recommended when the deposits has in its make-up a high carbon and a lesser oil content. Such a commercial material should have the necessary properties to inhibit against metal damage while it thoroughly dissolves lime scale, oxides and other soluble-in-acid deposits. Determining the solution concentrations, selecting the proper pumping equipment and performing careful, intermittent circulation of detergents in this class requires experience and good judgment. Here again the experience of service representatives of commercial detergent manufacturers who have worked on these procedures often should prove invaluable.

In extraordinary cases where a complex soil made up of both carbon and oil sludge is present on trays and bubble caps, a two-stage application of chemical cleaning materials may be necessary. First one chemical material is circulated to remove the oil-based deposits, followed by the circulation of a second type chemical to remove high carbon or scale content.

FIG. 5. Entrance bushing and electrode.

Equipment Set-up

As already pointed out, tower cleaning may be carried out effectively by circulation of a fast-acting, free-rinsing chemical material. The importance of determining the kind of deposits and the proper chemical to remove them have been discussed. Equipment for good circulation is very important. Basically it includes a solution tank, solution feed and return lines, pumps, and heating facilities.

The solution tank may be any container that is sufficiently large to handle the pre-determined amount of chemical solution which is to be circulated. Two or more small tanks hooked together near their tops by means of a short section of large

FIG. 4. Top view of demulsifier.

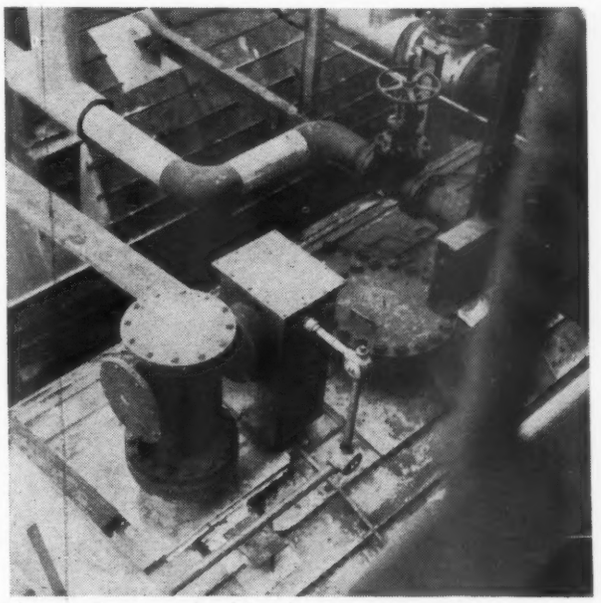


FIG. 6. Entrance bushing housing assembly and high voltage transformer.

FIG. 7. Electrical power rack.

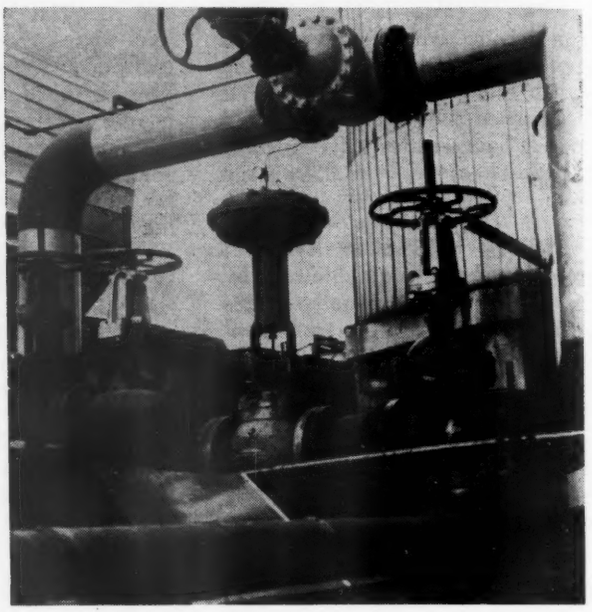


FIG. 8. Emulsifying valve.

diameter pipe may be used instead of one large tank. The container should be fitted with adequate drains and baffle arrangement. In many instances it is practical to use the base of the tower as the cleaning solution storage tank.

A duplex pump capable of delivering from 100 to 200 gal of the selected chemical solution per minute should be installed adjacent to the solution holding tank. Providing a good flow of solution is important because the higher the pumping rate the better the scouring action. Ordinarily one pump is sufficient if it is possible to get a gravity flow return of the solution as it comes from the bottom of the tower to the tank. If gravity feed is impossible, a second pump should be installed in the return line. Where this 2-pump system is used, it is essential to balance the discharge of the pumps in order to maintain a constant level in the solution heating tank.

The solution return line leading from the bottom of the tower to the top of the solution tank should be arranged to carry the solution downward through a length of pipe that terminates about ½ way down in the tank. This arrangement helps to keep the insoluble sludge at the bottom of the tank and allows the comparatively clean solution to overflow the baffle into the other section of the tank where it is re-heated and re-circulated.

It is also important to install a fine mesh strainer on the suction line between the tank outlet and the pump. This mesh strains out the hard insoluble deposits loosened by the circulation of the chemical cleaning material through the tower, helping to make circulation easier and faster.

Provision should be made to heat

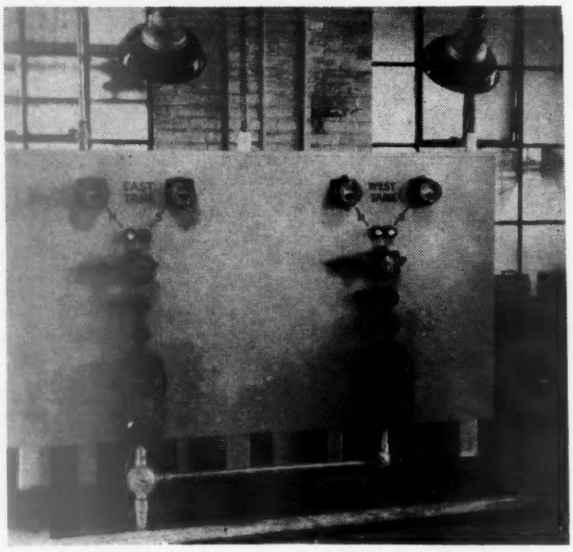


FIG. 9. Desalter electrical control panel.

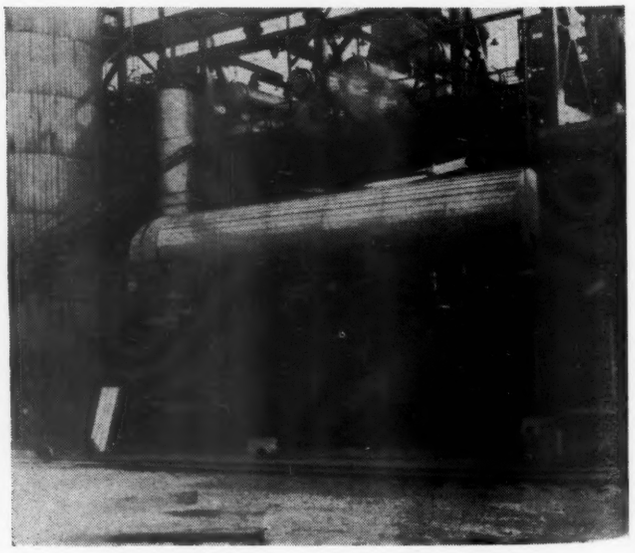


FIG. 10. Settling tank and west demulsifier.

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the solution so maximum cleaning results may be obtained. The technical service representatives of the chemical manufacturer can helpfully advise on the temperature at which the cleaning solution will do its best work. Heat helps especially in preparing the solution because it makes for a homogenous mixture by properly distributing the chemical material throughout the solution; thus all parts of the solution are equally and completely effective. In some instances it may be possible to provide this heat by installing a steam coil in the solution tank. Or it may also be feasible to hook in a heat exchanger at the discharge end of the pump to heat the solution. If not, it is usually satisfactory to utilize live steam by delivering it directly into the solution tank. It has also been found advantageous to discharge live steam into the tower to maintain the temperature at which the cleaning solution does its best work.

Circulation of the Chemical

It is recognized that there are a great many styles and sizes of towers, and various designs of trays and caps all scientifically designed to handle the manifold processing jobs which towers are required to do. Necessarily, then, the method of cleaning those towers by circulation of a chemical cleaning solution is generalized here so that the fundamental idea should suggest procedures that are applicable to individual requirements.

The procedure should start with hot water flushing of the tower; steaming out is not recommended because that often bakes-on the deposits. Flushing out removes loose oil and debris. Next the chemical cleaning solution should be pumped through the line to the top of the tower. It sprays down over the trays, bubble caps, going through downcomers to the next tray, eventually being drawn off at the bottom of the tower, returned to the solution tank and strained for continuous recirculation. The time required for the circulation-cleaning procedure depends on the amount and the tenacity of the soil being removed. When testing by titration, which should be performed at regular intervals during the cleaning procedure, shows that the cleaning action has been completed, all the solution should be drained out of the tower and the solution container. When the solution container is a separate tank, it may be practical to fill it with clean water which is then circulated through the tower until there is no further evidence of residue being brought down through the return line. When small towers are being rinsed, and the conditions are favorable, the tower itself may be filled with the rinse water.

With the use of chemical materials to remove scales and oxides by circulation, it is important to follow the circulation procedure immediately with a hot water rinse and neutralization process. This successfully ends the action of the cleaning material and leaves surfaces clean for efficient processing.

Summary

The method of cleaning towers by the continuous circulation procedure recommended here offers an excellent opportunity to cut costs and reduce equipment out-of-service time. This method is not confined to tower cleaning; however, tube bundles of heat exchangers may also be tied into the cleaning solution circulation set-up and cleaned as part of the entire processing system. Or the heat exchanger may be isolated from the tower and cleaned by the circulation method. Procedures for this latter work were discussed by the author in the May issue of *The Petroleum Engineer*.

The important advantages of cleaning by circulation of specialized chemicals are sure to appeal to refinery maintenance superintendents. Likewise the availability of expert advice on all the problems involved should be of great interest. That is why it is advisable under most conditions to contact one of the representatives of a manufacturer of specialized industrial cleaning materials who is experienced in petroleum maintenance work. Helpful information can be readily obtained from these representatives who can be contacted most everywhere in the continental United States and Canada, or by writing to the author who is a member of the Technical Forum of *The Petroleum Engineer* magazine.

* * *

HOW TO FIND PIPE LEAKS EASILY

W. F. S.

When a concealed pipe leaks, to locate the leak at minimum expense; fill the pipe with water—until it overflows. Close all of the valves that hold the water against gravity. Allow as much water to leak out as *can* leak out, say, overnight.

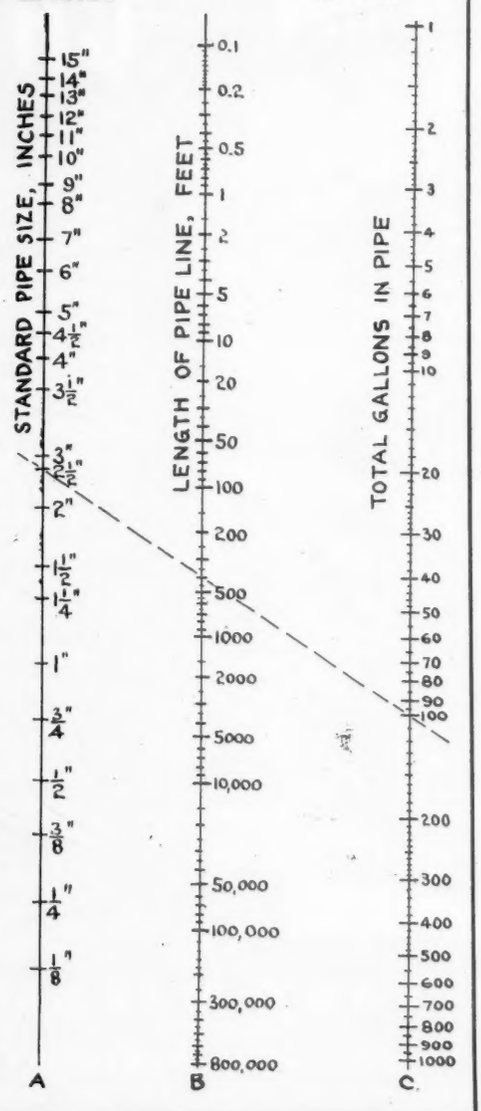
At a suitable interval, using a calibrated can, pour in water until the pipe is filled flush with the top. Note exact amount of water poured into pipe.

Multiply the inside diameter of the pipe in inches by itself, then multiply by 0.7854, and divide the result into the number of cubic inches of water poured into the pipe. The quotient is the distance to the "trouble spot" in inches.

By this means, leaks can be located with amazing accuracy resulting in minimum cost for repair work where the piping is concealed. And the same method is often applicable to pipes that are stopped up.

To assist in determining the number of gallons in any pipe, here is a handy chart. The chart includes more than average conditions. To use it run a straight line through the pipe size (Column A) and the gallons of water poured into the pipe, Column C, and the intersection in Column B immediately gives the location of the trouble spot, in feet distance from the filling point.

For example, the dotted line shows that if the pipe size is 2½ in. (Column A), and if 100 gal of water are poured into the pipe, Column C, the trouble spot is 400 ft away, Column B.



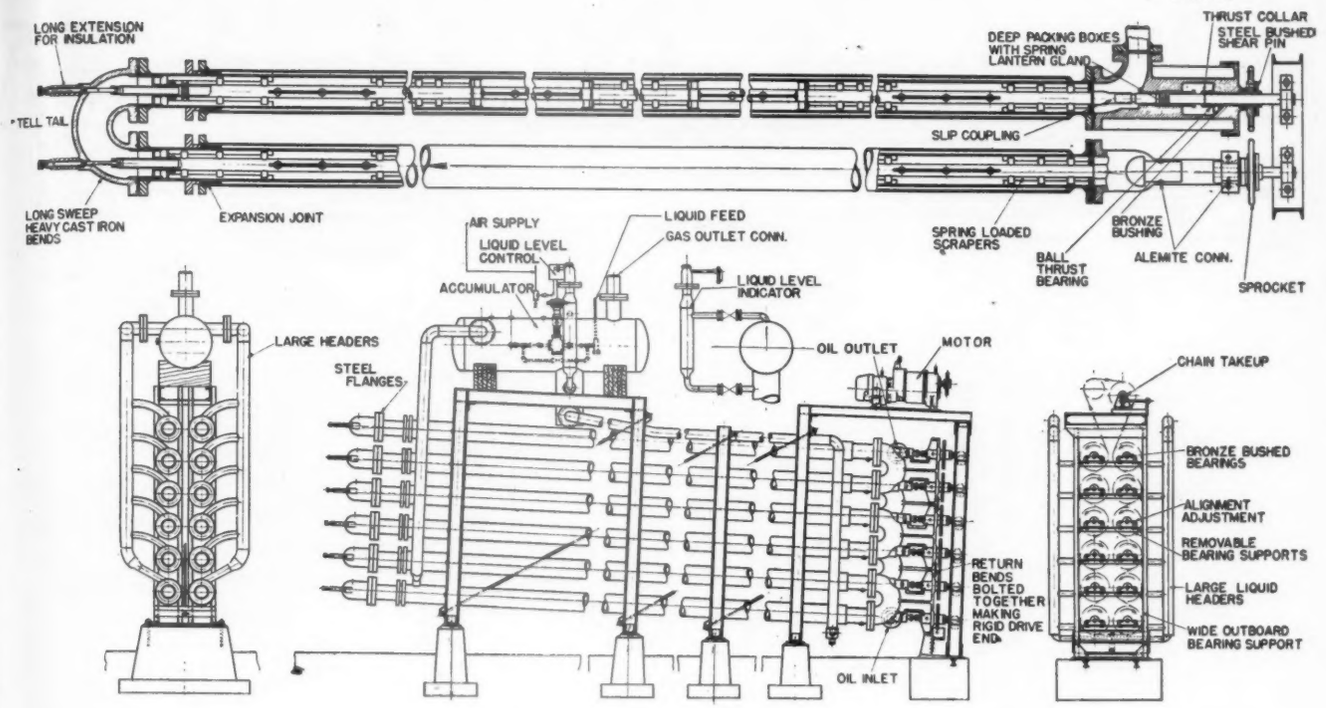


FIG. 14. Inclined direct expansion chilling machine.

Refrigeration in the Petroleum Industry

Refining and petrochemical processes that employ refrigeration and choice of reciprocating and centrifugal compression systems.

J. CHARLS, JR.*

Part 2—Conclusion

In the past few years, there has been a heavy demand for lube-oil plants. The majority of these plants used solvent dewaxing as licensed by The Texaco Development Corporation, for separation of wax-free oil from oil-free wax.

The solvent usually employed is a mixture of methyl-ethyl-ketone, benzol, and toluol. Normally, each of the solvents in the above mixture serves as follows: Benzol retains oil in complete solution at dewaxing temperature; methyl-ethyl-ketone acts as an anti-solvent, preventing the wax from remaining in solution at the dewaxing temperature; the action of toluol is similar to that of benzol, but has the added advantage over benzol of preventing benzol crystals from forming at dewaxing temperature.

A typical flow of this type is as follows: The waxy oil solvent charge mixture, consisting of oil stock to be dewaxed and solvent, is first chilled by water to about 110 F, then passed through 6-in. pipes of double pipe scraped-surface exchangers, where it is cooled by exchange with cold dewaxed filtrate. Final chilling is obtained by passing the charge stock through the 6-in. pipes of direct-expansion inclined chilling machines also fitted with spring-loaded scrapers. The refrigerant may be either ammonia or a hydrocarbon.

After being chilled to the final desired temperature, the charge oil and solvent mixture enters the filter feed tank, whence it is fed by gravity flow to rotary-type vacuum filters for the removal of wax. The wax-free filtrate solution or dewaxed filtrate is collected in the main filtrate receiver and is then pumped through the annular space of the double pipe exchangers to evaporators for recovery of solvent and further finishing of the oil.

Refrigeration is utilized for cooling of the solvent, flue gas, and charge-stock mixture.

From the above you have noted that double pipe exchangers and chillers are employed for cooling and final chilling of the waxy-oil charge. Typical of the double chiller and exchanger installations are those shown in Figs. 14 and 15.

In the double pipe chilling machines, the liquid refrigerant is fed into an accumulator, where the flash gas resulting from change in pressure of the liquid refrigerant is re-

*Air Conditioning and Refrigeration Division, Worthington Pump and Machinery Corporation.

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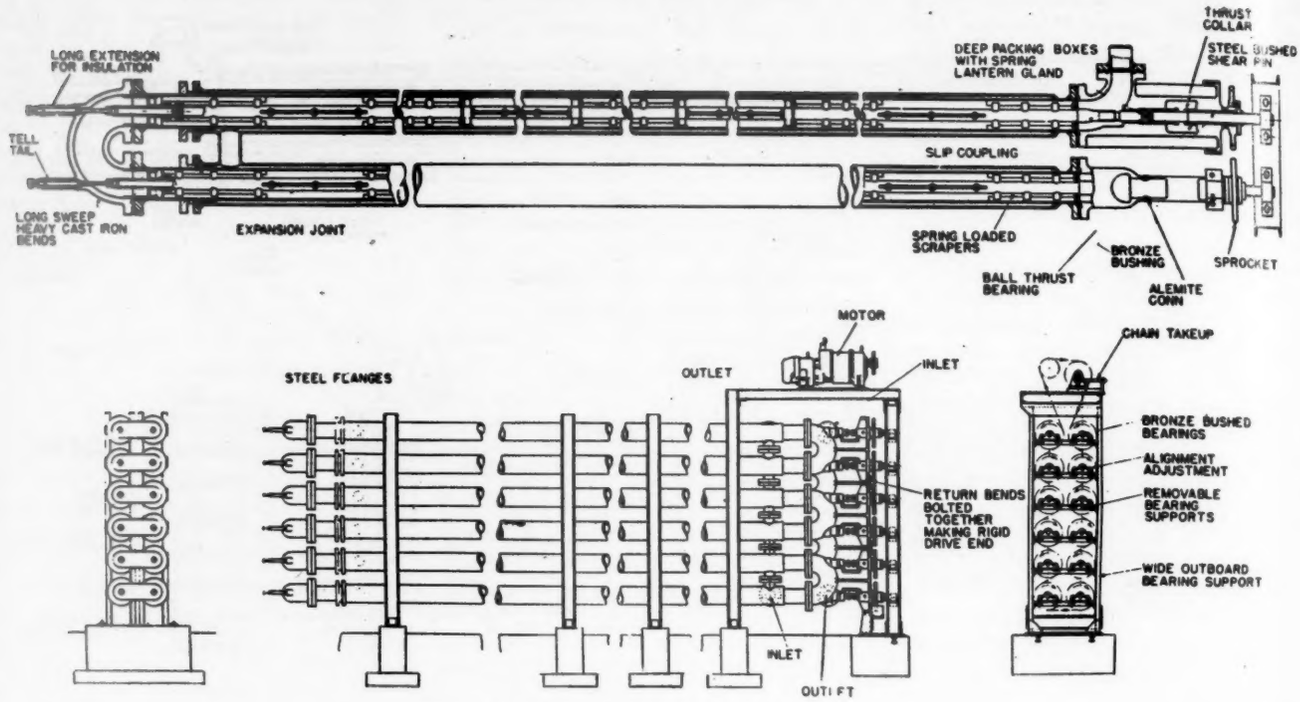


FIG. 15. Horizontal double pipe exchanger.

leased and flows to the refrigeration compressor without passing through the chilling machine. Liquid refrigerant at its saturation temperature is fed to the annular space between the inside and outside pipes, where evaporation takes place. The flow of liquid refrigerant is by gravity to the bottom of section at the front end or drive end of the chilling machine. You will note the liquid headers on both sides of the chilling machine. Any excess refrigerant in each section is swept through the annular space and returns, with the vapor formed by evaporation, to the accumulator through gas headers. The chilling machines are inclined in order to obtain circulation of the liquid refrigerant and prevent gas binding, with resultant slopover.

The charge stock, consisting of oil, solvent, and wax, passes through the inner pipes. Heat from the charge stock is transmitted to the refrigerant in the annular space. The surface of the inside pipe is kept clean of precipitated wax by spring-loaded scrapers.

The construction of exchangers is similar to the construction of chilling machines, except that they are not inclined and do not employ a refrigerant for the cooling of charge stock. Instead, refrigeration is recovered from the dewaxed cold filtrate, which is circulated through the annular space.

As the various refinery products increased, the need for refrigeration at both low- and high-temperature levels also increased. Ammonia was the principal refrigerant, but, later, when hydrocarbons became available at plant site, they gradually replaced other refrigerants. Reciprocating compressors had proved successful in compression of hydrocarbons in other plant processes. The normal reaction was to use hydrocarbons as refrigerants, in order to eliminate the purchasing of a refrigerant from an outside source. Depending upon temperature levels, such hydrocarbons as butane, isobutane, propane, and propylene are substituted for ammonia.

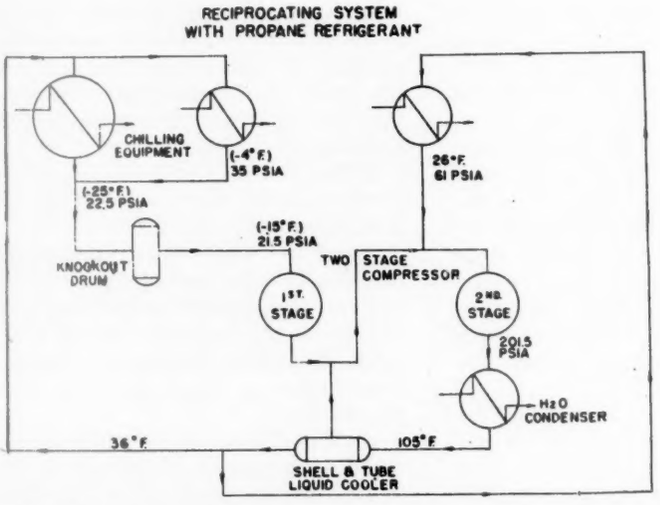


FIG. 16. Reciprocating compressor system using propane refrigerant.

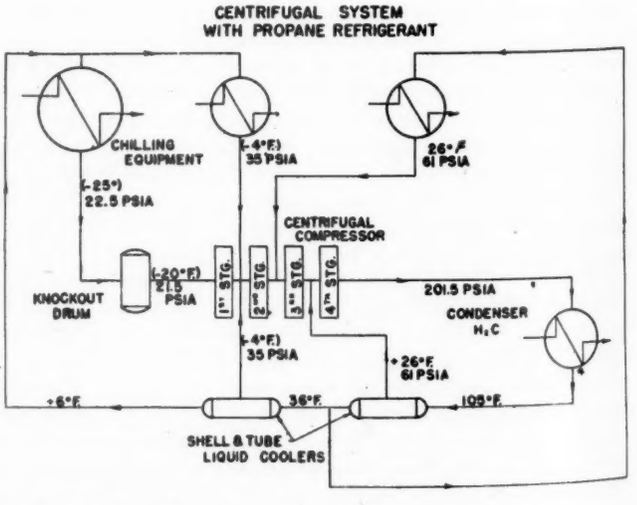
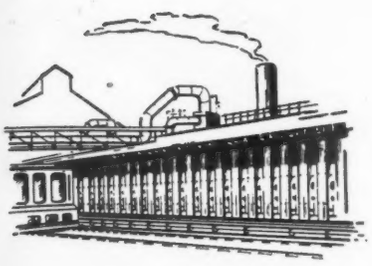
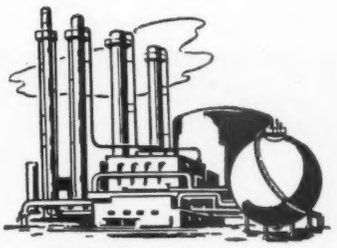


FIG. 17. Centrifugal compressor system using propane refrigerant.

Make H_2SO_4 from H_2S

WITH A CHEMICO PLANT





H_2S DERIVED FROM COKE OVEN GAS

H_2S DERIVED FROM NATURAL GAS

H_2S DERIVED FROM REFINERY GAS

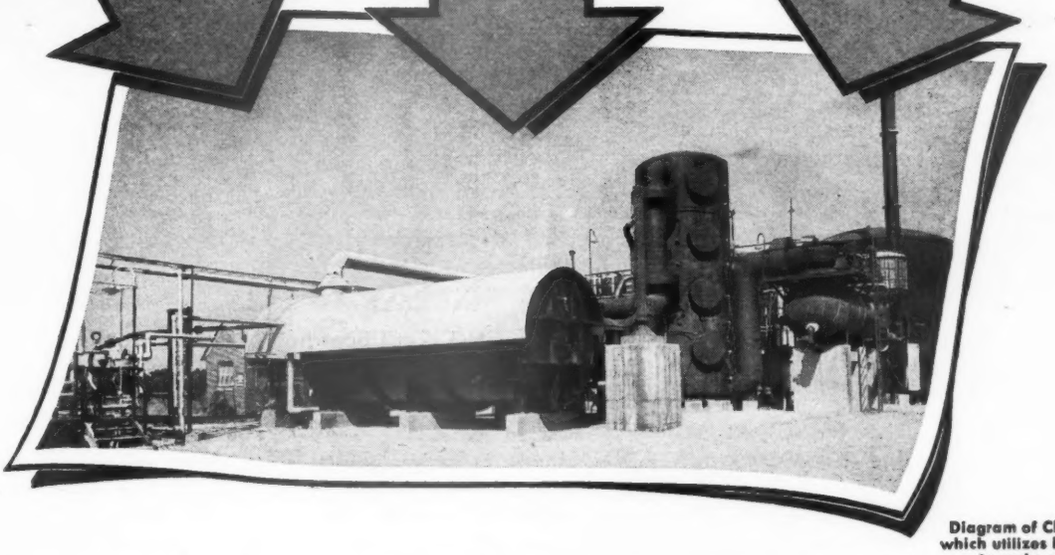
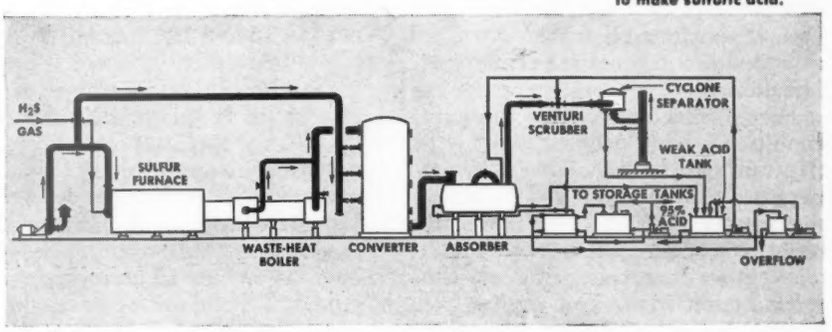


Diagram of Chemico process which utilizes hydrogen sulfide to make sulfuric acid.

Now that raw sulfur is in short supply, it has become necessary to manufacture sulfuric acid from other raw materials such as hydrogen sulfide. If you have hydrogen sulfide available, it will pay you to investigate Chemico's practical and proven process for making H_2SO_4 from H_2S. Chemico's new type sulfuric acid plant is especially well suited for this purpose. Or existing sulfuric acid plants can be converted.



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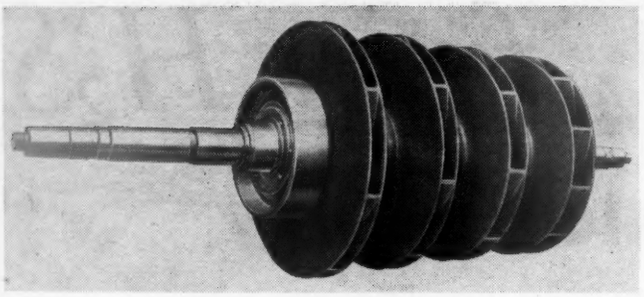

FIG. 18. Typical four-stage centrifugal compressor rotor.

FIG. 19. View of impellers (above, center) in a centrifugal compressor rotor.

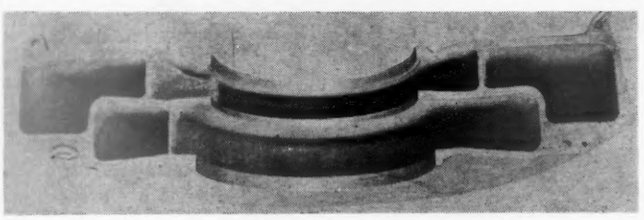

FIG. 20. Volutes that received higher pressure gas in a compressor.

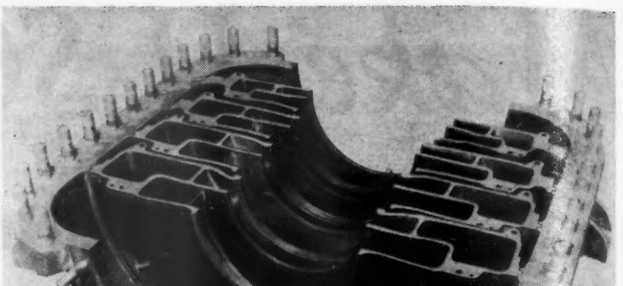

FIG. 21. Lower half of centrifugal compressor casing, with twin volute halves inserted.

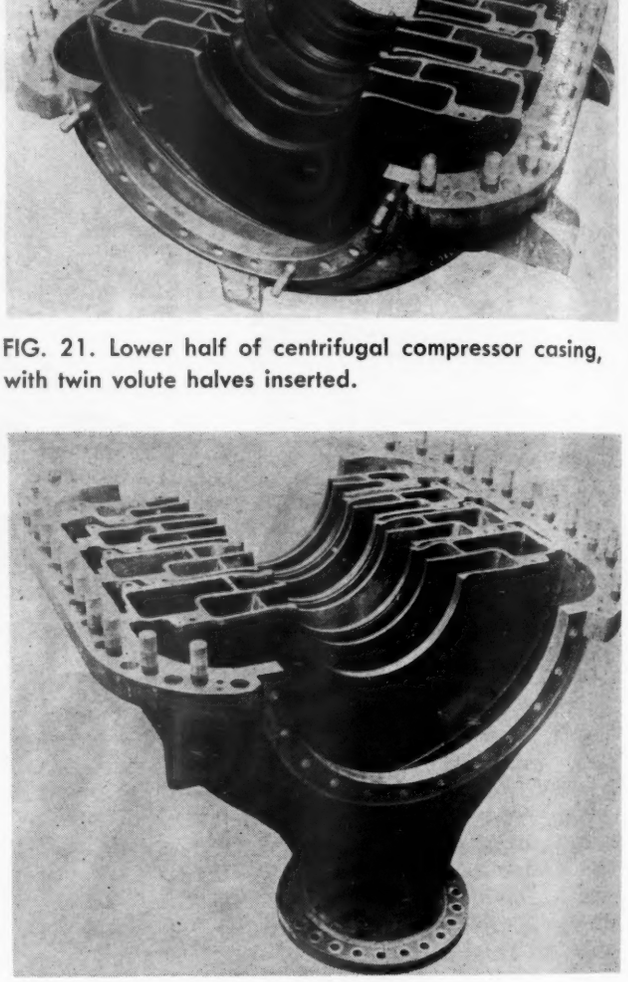

FIG. 22. Upper half of compressor casing with volutes installed.

In view of the increasing demand for hydrocarbon refrigerants and lower temperatures for synthesis, various manufacturers developed centrifugal compressors for hydrocarbon service. It was found that the centrifugal compressor was ideal for refinery applications.

For normal present-day dewaxing conditions, with propane as the refrigerant and for an evaporating temperature of minus 25 F and a condensing temperature of 105 F, it is the usual practice to install two-stage reciprocating compressors to carry the refrigeration load. For similar conditions, a four- or five-stage centrifugal compressor would be used. Where multiple loads of large volume occur simultaneously at different temperature levels; however, the centrifugal compressor offers greater flexibility than the reciprocating. The additional stages of a centrifugal permit injection of high-level loads at more points, eliminating the necessity of throttling from a high pressure to a much lower pressure, with consequent decrease in horsepower.

Figs. 16 and 17 illustrate the above. Fig. 16 covers a multiload reciprocating cycle with refrigeration required at plus 26 F, minus 4 F, and minus 25 F. This application would require a two-stage compression system. You will note the refrigerant is propane. Liquid subcooling is performed between stages. Subcooled liquid at plus 36 F is fed to all evaporators. The minus 25 F and minus 4 F evaporator gas is handled by the first stage of compression, while the plus 26 F evaporation is injected to the second stage of compression. As the first stage of compression suction pressure is dictated by the minus 25 F evaporator condition, it is necessary to lower the pressure of the minus 4 F evaporator to the suction pressure of the first stage. This means a pressure drop of 13.5 lb, and a corresponding increase in horsepower requirements.

A three-stage compressor could be installed with the first stage working between pressure level of 21.5 psia to approximately 35 psia, the minus 4 F load being injected at this point. Because of the low compression ratio, however, the horsepower saving would be small and a more costly compressor installation would be required.

In comparison, on substituting a centrifugal selection for the same operating conditions (Fig. 17), the following will be observed. Two steps of liquid cooling are included, providing colder liquid for expansion to the minus 4 F and minus 25 F evaporator, with corresponding increase in refrigeration effect and resulting decrease in pounds flow from these two evaporators. Four stages of com-

pression are available, providing means of injecting the minus 4 F evaporator load at a pressure close to its operating pressure or refrigerant pressure required to produce the minus 4 F temperature.

The reason for two steps of liquid cooling, one placed between the first and second stages, the other between the third and fourth stages, is to decrease the over-all horsepower by *decreasing* the volume of gas to the first stages of compression, where efficiencies are normally high, and *increasing* the gas volume to the last stages by the amount of flash gas resulting from liquid subcooling, with resultant improved efficiencies in the last stages of compression.

Inherently, the centrifugal compressor is a large-volume machine. For capacities lower than 1500 to 1700 cu ft per min at initial suction, the over-all efficiency is low, the advantage therefore being in favor of reciprocating equipment. Temperature levels, duty, availability of refrigerants, and plant conditions will dictate whether it is more economical to install a reciprocating or centrifugal-refrigeration system.

There are two main types of centrifugal compressor designs, the diffuser and the volute. A centrifugal refrigeration compressor consists of the following main components:

(a) *A rotor* (Fig. 18) composed of *impellers* (Fig. 19) to provide a means of lifting the gas from a lower pressure to a higher pressure and discharging this lifted gas into *volutes* (Fig. 20), where pressure is obtained by means of converting the velocity energy obtained through centrifugal force of the impeller into pressure energy or pressure, by passing this gas through a passage whose area increases as the gas exit is approached.

(b) A *casing* or wrap-around to provide a means of rigidly holding the volutes in place and also withstand final suction and discharge pressure [The lower half and upper half of a casing with volutes installed are shown (Figs. 21 and 22)].

(c) A *self-contained lubrication system* (Fig. 23), complete, with auxiliary and main oil pump together with means of releasing the absorbed refrigerant from the oil.

(d) A *means of preventing* refrigerant from leaking from the shaft during operation and shutdown. [This shutdown seal should automatically close when compressor and auxiliary oil pump have been shut down and open when the operating seal (oil in bearings) has sufficient oil pressure derived from either the auxiliary or main service oil pump.]

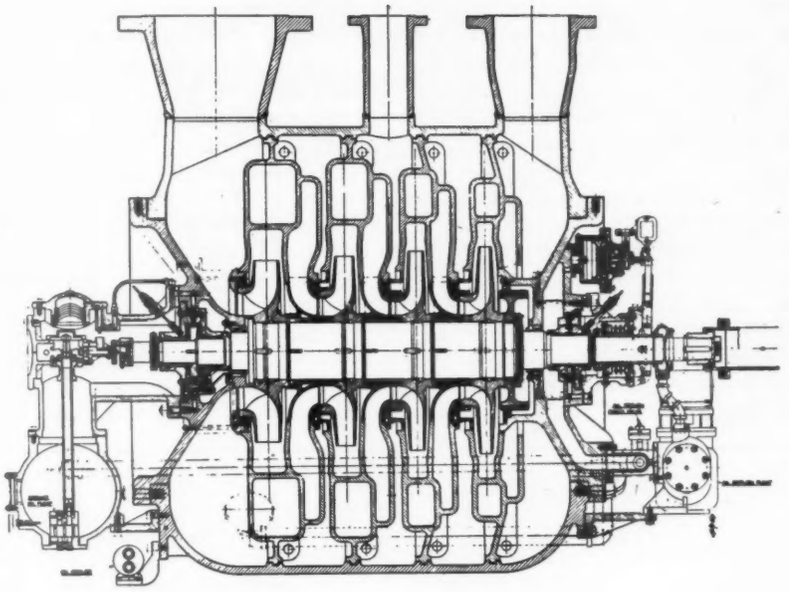

FIG. 23. Cross-section of compressor showing self-contained lubrication system. (See text.)

In Fig. 23, covering a four-stage centrifugal propylene compressor, beginning at the left, is the oil reservoir containing the main oil pump and auxiliary oil pump. At the extreme top of the pump are screens, which serve as impingement baffles to remove oil contained in the gas flashing off the main-sump oil. The flash gas is vented to the initial suction of the compressor and thereby removed from the oil sump. The suction side of the compressor is at the oil-sump end. The rotor consists of a thrust bearing, a line shaft bearing, four impellers, and a balancing drum. The impeller diameters increase from suction to discharge side, whereas the width of each impeller decreases. This is called stepped-rotor construction. The volutes are contained in the casing and positioned by means of a tongue-and-

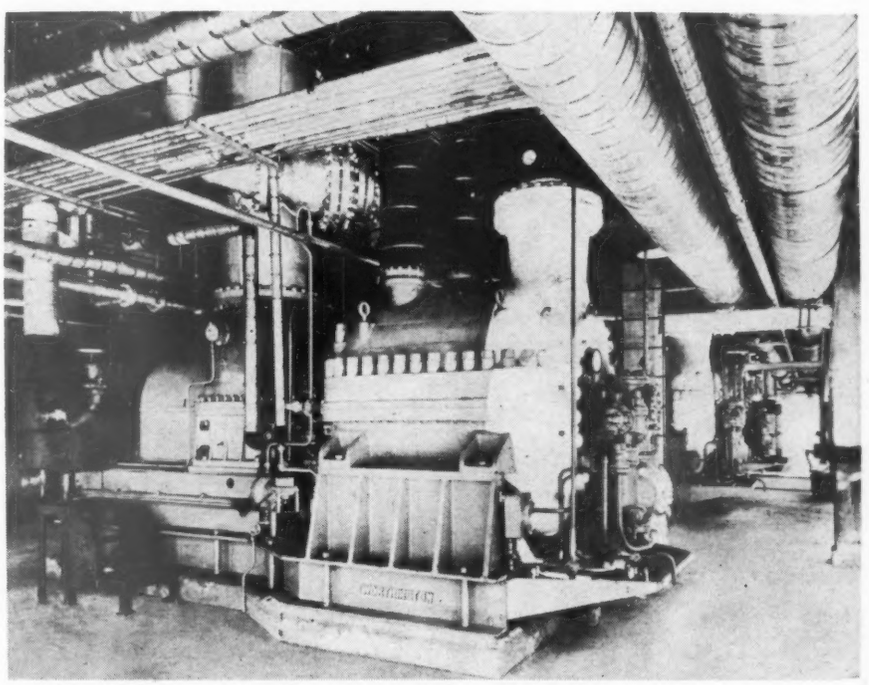

FIG. 24. Three-compressor centrifugal installation in a Gulf Coast lube plant, employing propane as refrigerant for a solvent dewaxing process.

groove joint. Three nozzles are apparent, the two end ones being for suction and discharge, the intermediate being a flash nozzle to take care of the gas resulting from a liquid-cooling step. Below the discharge nozzle is the shutdown-seal-diaphragm operating element, which is oil-actuated.

The impellers are made of cast alloy steel for all temperature applications, whereas the casing may be cast iron, fabricated steel, or cast alloy steel, depending upon the refrigerant and temperature level conditions.

Typical of turbine-driven installations for this type of equipment is the installation in a Gulf Coast lube plant (Fig. 24), where a three-compressor plant installation, with plant propane as the refrigerant, supplies refrigeration for a solvent-dewaxing process. Each compressor and turbine driver are mounted on a common baseplate and are direct-connected by a spacer type coupling.

Chemically, petroleum consists mainly of carbon-hydrogen compounds, paraffins, napthenes, and aromatics. The paraffins exist as waxes at normal temperature ranges and are removed from the various lube oils by chilling and filtration after distillation. Separation of the crude into various constituents or fractions is accomplished by distillation. In this step, the lower-boiling components are separated from the lubricating-oil fractions and processed for special fuels, cracking stocks, and solvents. There are over 5000 essential products that are derived from the initial crude charge.

Before the dewaxing step, hydrocarbon mixtures are separated on the basis of the solubilities, in order to obtain their desirable properties. By use of solvents, the paraffinic, naphthenic, and aromatic compounds can be separated and individually processed, as, for example, in the Duo-Sol process for separation of naphthenic and paraffinic compounds, the *Edeleanu* process for solvent refining, for

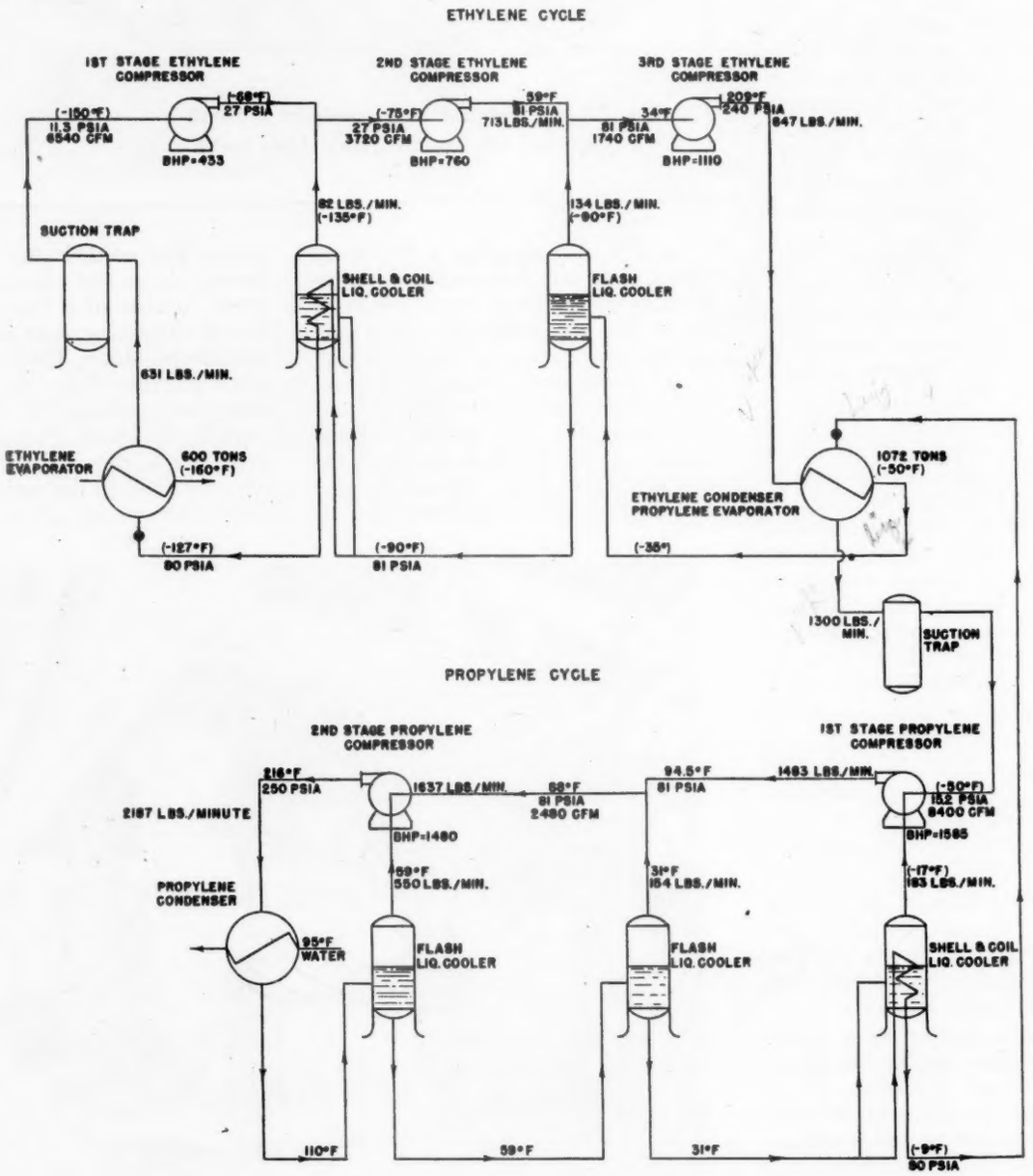

FIG. 25. Low-temperature refinery refrigeration cycle using two refrigerants.

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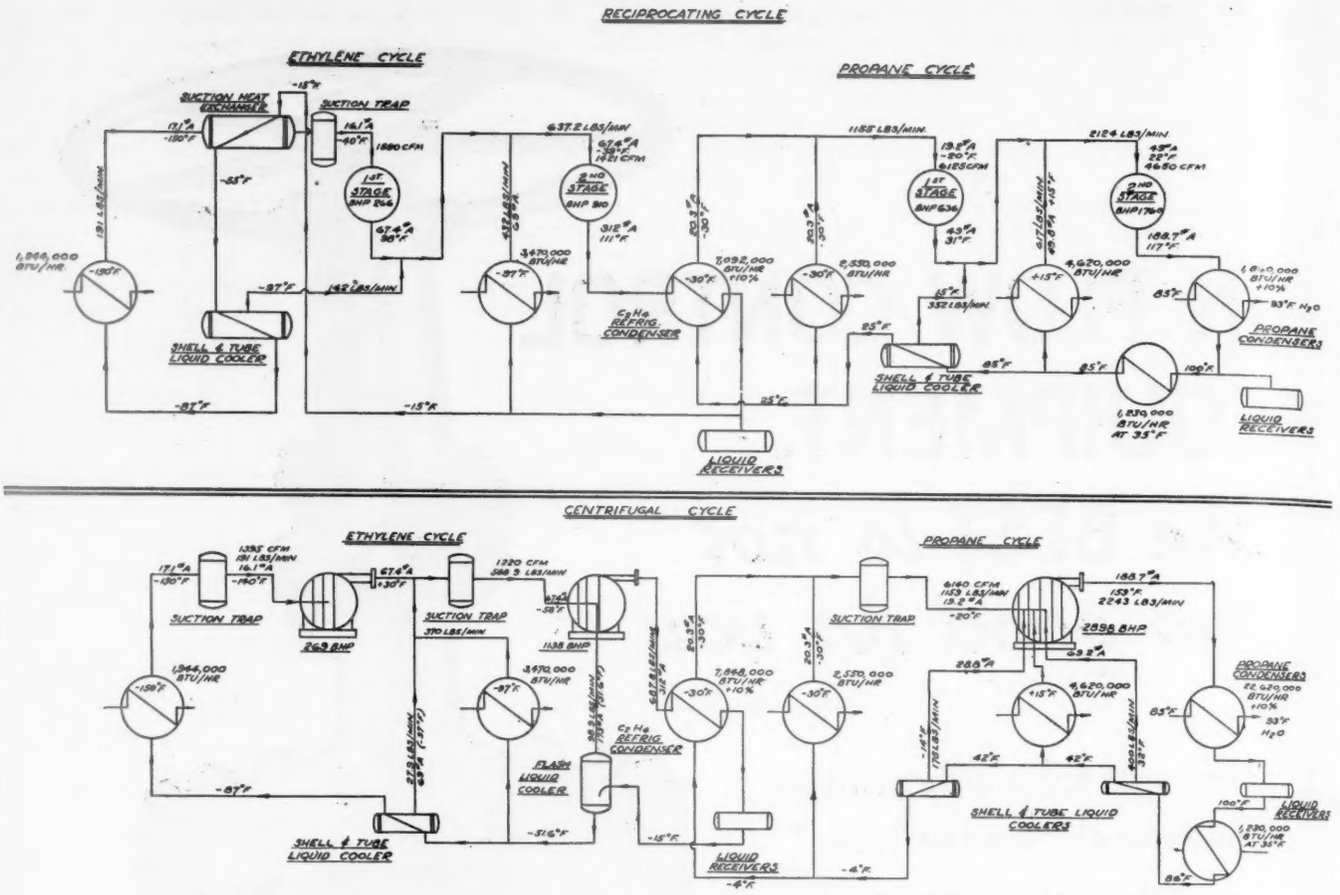

FIG. 26. Ethylene recovery unit employing both reciprocating and centrifugal compression.

quality improvement of kerosine, separation of aromatics from naphthas, and production of aviation-gasoline blending stocks.

In the Edeleanu process, the solvent, sulfur dioxide, is also used as a refrigerant. Refrigeration is obtained by the evaporation of the solvent in the charge and sulfur dioxide cooler.

Recovery of the light hydrocarbons and their corresponding separation and purification demanded lower refrigeration temperatures and the use of cascade refrigeration cycles. In a cascade system, two refrigerants are used. The refrigerant for the low temperature or low level is condensed by another refrigerant, which can be condensed by water without abnormal refrigerant condensing pressure.

Fig. 25 illustrates a single load at minus 160 F. The refrigerant in the low end of the cycle is ethylene, whereas, in the upper level, it is propylene. The evaporator load for the ethylene cycle is 600 tons of refrigeration, requiring three centrifugal compressors operating in series to compress the ethylene gas from 11.3 psia to 240 psia, or, the condensing pressure.

Two types of liquid cooling are shown, one employing a flash-liquid cooler situated after the condenser for the initial step of liquid cooling and the other a shell-and-coil-type, for subcooling of the liquid prior to feeding to the evaporator. Total brake-horsepower requirement for the ethylene cycle is 2303. The ethylene is condensed at minus 35 F with minus 50 F propylene. The condensing load for the ethylene cycle is 1072 tons of refrigeration.

The propylene system operates from an initial pressure of 15.2 psia to a condensing pressure of 250 psia. Two centrifugal compressors operating in series comprise the compressor equipment. Liquid intercooling is performed in three steps. Propylene-cycle brake horsepower is 3065.

Fig. 26 is a flow diagram for an ethylene-recovery unit. The refrigerant system is cascade, using reciprocating compressors in one case and centrifugal compressors in another. All initial temperature levels, heat loads, and refrigerants are identical.

The flow for the reciprocating cycle is as follows: Ethylene gas from the minus 150 F evaporator passes through a suction-heat exchanger to be superheated to minus 40 F. The superheating is obtained by exchange with warm liquid refrigerant. Superheating is required in order to use an oil that will lubricate the compressor cylinders at this temperature and at a higher temperature, encountered in the second stage of compression. The discharge gas from the first stage of compression is mixed with the flash gas resulting from subcooling of the liquid from minus 55 F to minus 87 F, and the gas coming from the minus 97 F evaporator. The total gas flow is compressed to condensing pressure, where it is condensed at minus 15 F with minus 30 F propane.

One step of liquid subcooling is performed in the ethylene cycle between the first and second stages of compression. As previously mentioned, further liquid subcooling is obtained in the suction heat exchanger. The temperatures of the liquid being fed to the minus 97 F evaporator and minus 150 F evaporator are minus 15 F and minus 87 F, respectively.

The propane cycle consists of three main heat loads, two of which occur at minus 30 F and the other at plus 15 F. The compression equipment is of the two-stage type, the minus 30 F loads being handled by the first stage, the second stage of compression handling the gas mixture resulting from the combination of gas from the liquid subcooler, plus 15 F evaporator, and the first stage of compression (discharge gas). Condensing of the pro-

pane occurs at 100 F or 188.7 psia. The liquid refrigerant is cooled by an external source from 100 F to 85 F prior to being subcooled to 25 F. Total brake-horsepower requirement for the cascade system is 3572.

On the assumption that gas-engine-driven compressors are the desired type of compression equipment, two 600-hp compressors or one 1200-hp would be installed as main operating units for the ethylene cycle, whereas two 1200-hp or four 600-hp units would be installed for the propane cycle. The choice of 600-h.p. or 1200-hp compressor units would depend upon flexibility requirements and the amount of sparing desired.

Particular attention is called to the final discharge temperature in both the ethylene and propane systems. Both of these gases have low specific-heat ratios, but, in the case of the ethylene refrigerant, whose gas has a higher ratio of specific heats, the final discharge temperature is aided by the injected gas between stages resulting from the minus 97 F evaporator and liquid cooler, which, when mixing with the gas from the discharge of the first stage of compression, lowers the gas temperature from plus 98 F to minus 39 F.

In the centrifugal compression cycle, the ethylene gas from the minus 150 F evaporator flows directly to the suction of the compressor. Lubrication is not a problem, inasmuch as the bearings of the compressor are sealed from the gas stream, with consequent lack of oil in the refrigerant cycle. The ethylene-compression equipment consists of two three-stage compressors in series. Gas from liquid cooling and the minus 97 F evaporator is mixed with the ethylene gas coming from the first compressor in series. Liquid cooling is in two steps, one occurring between stages of the upper-level ethylene compression and the other between the two centrifugal compressors. You will note that the liquid temperature to the minus 150 F evaporator is the same as that in the reciprocating cycle.

The final discharge temperature is higher than in the reciprocating cycle, which shows the difference in efficiency between the two types of compression equipment.

The propane cycle consists of one five-stage centrifugal compressor. The two steps of liquid subcooling are performed between stages of compression, and the plus 15 F evaporator load is injected between stages of compression. Total compressor brake horsepower for the centrifugal ethylene and propane cycle is 4305. This is an increase of 733 bhp over that in the reciprocating cycle. * * *

3 aids for refinery engineers

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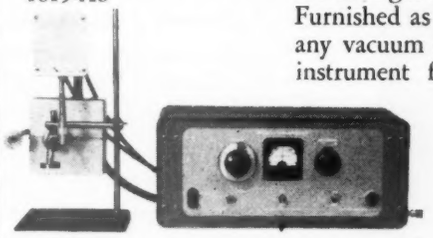

Model 23-105 Consolidated Micromanometer accurately measures gas pressure in the 0-150 micron range *without knowledge of the composition of the gas.* The pressure readings are independent of the fact that gas might be air, a condensable vapor, or an unknown mixture. Pressure changes as small as 0.1 microns can be detected. Because of this, special calibration charts for each gas are eliminated.

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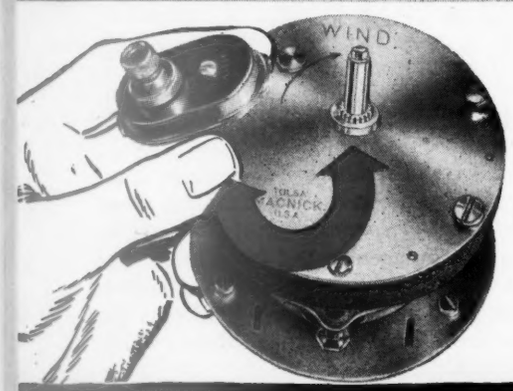

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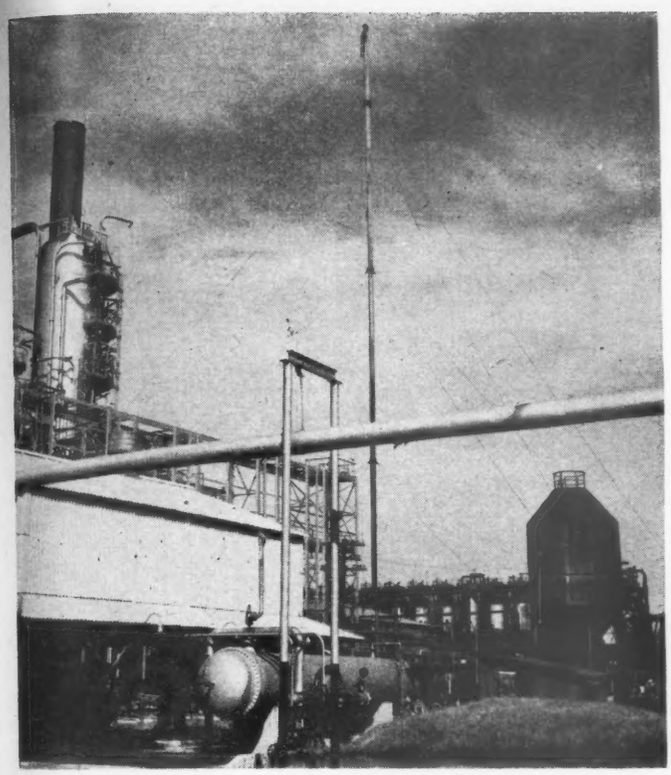
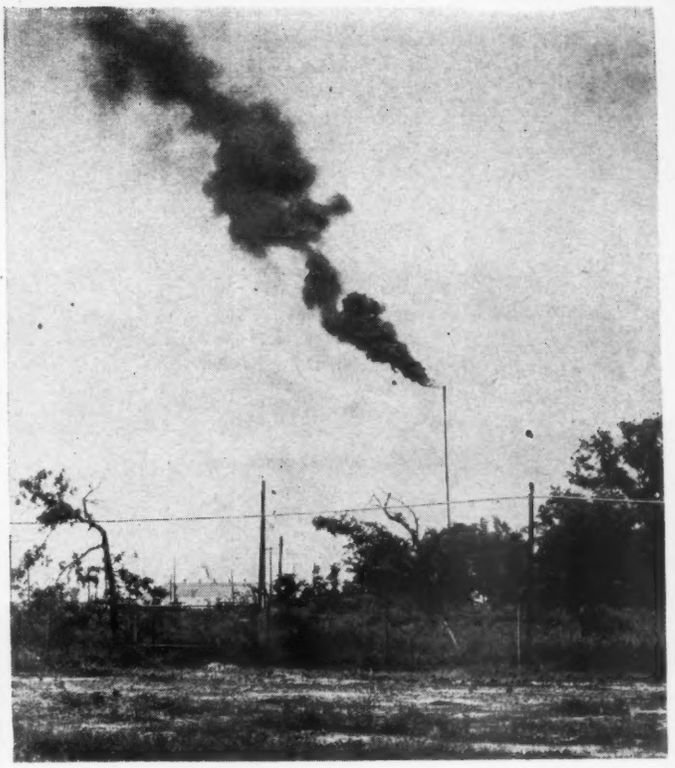


Steeple jacks install ignition device top of 300-ft high, 2-ft diam flare stack.



Gas being burned at the top of a 200-ft flare stack.

Flare Stack Ignition Devices

Unique problem solved by new instrument that lights waste gas stream by "remote control."

O. L. CLEVENGER and W. A. McELHANNON

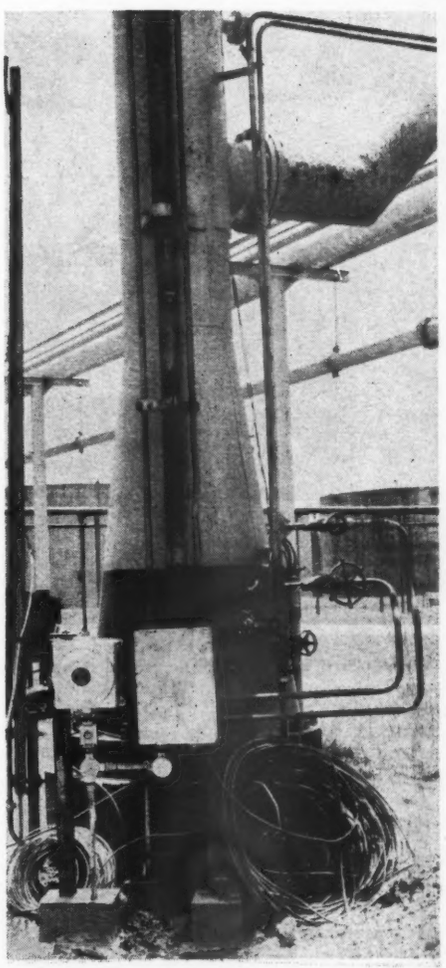
ONE of the problems that has confronted the petroleum refining industry for many years has been the disposal of waste gases. Probably the method most widely used for disposing of these gases is by burning at the top of tall stacks.

This method in turn presents the interesting yet perplexing problem of lighting and keeping lighted the pilot light on elevated flare stacks.

Many types of lighters have been tried ranging from elaborate sparking devices and gas fired ladders, to raising burning torches to the top of the stacks by cables. In some instances tracer bullets and flares have been shot through the gas at the top of the stacks. These methods have met with varying degrees of success, none having proved entirely satisfactory.

Recently a distinctly different method was developed and put in operation at the Baytown refinery of Humble Oil and Refining Company.

This method consists of a 1-in. continuous pilot gas line, running from the ground to the top of the stack, and a 2-in. pipe approximately 10 ft long placed adjacent to the 1-in. pilot line at the top of the stack. The 2-in. line is perforated at its lower end and is connected at this end to a ⅜-in. copper tubing extending to a needle valve and a gas supply line at the base of the stack. Also inside the lower end of the 2-in. pipe is an electrical heating element with leads extending to a trans-



Ignition device assembled at base of flare stack for testing before erection by steeple jacks.

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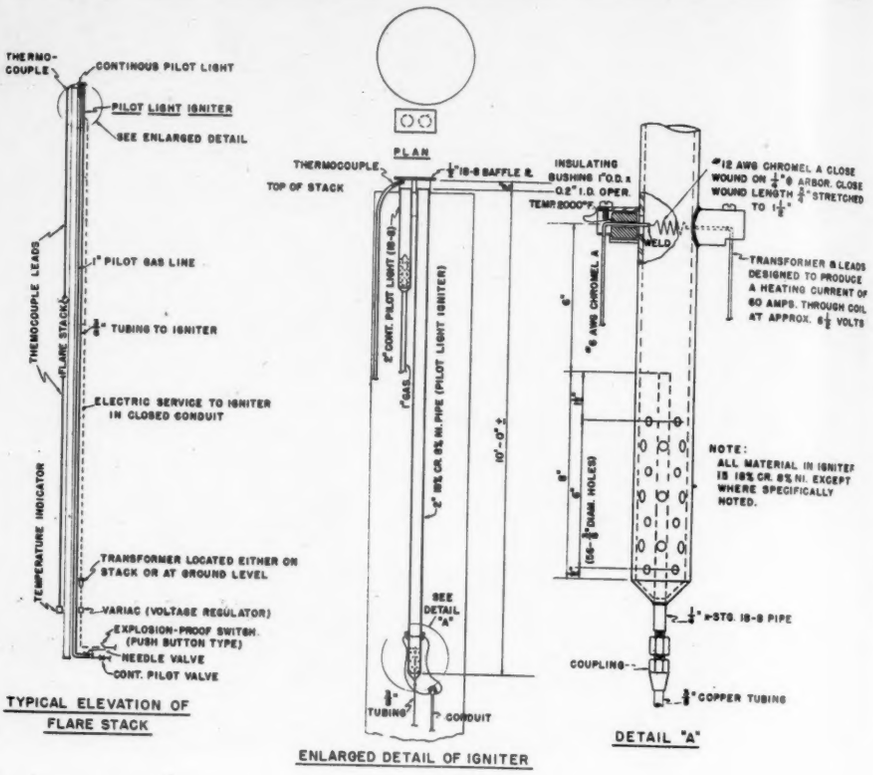

FIG. 1

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former and an explosion proof switch at the base of the stack. The general arrangement and details of this igniter are shown in Fig. 1.

To ignite the pilot the switch is closed at the base of the stacks, which energizes the heating element with a low voltage current. This current is so regulated that the element reaches a maximum temperature of approximately 1800 F in 20 sec. When the element has become heated a small amount of natural gas is introduced into the lower end of the 2 in. pipe through the ⅜-in. tubing and is mixed with air, which enters through the perforations. On contact with the heated element this combustible mixture is ignited and the flame travels through the 2-in. pipe to the top of the stack where it ignites gas coming from the continuous pilot. This method has been in continuous use for approximately one and one-half years on stacks ranging in height from 200 to 300 ft.

Advantageous features of this igniter are: As no open flames or sparks are required at the base of the stacks, it is not necessary to obtain a gas test to see if a combustible mixture of hydrocarbons is present at the base of the stack before operating the ignition device; there is no danger of an explosion due to improper mixture of gas and air in the ignition line, as would be the case if a combustible mixture of air and gas were introduced at the base of the stack; and the heat source for ignition is a low voltage heating element, which avoids the difficulties of insulation encountered with spark ignition devices.

On clear days it is impossible to see if the pilot light at the top of the stack is burning. To overcome this difficulty a thermocouple has been placed at the top of all stacks with leads extending to temperature indicating instruments placed at the base of the stacks or in the control houses serving the units in which the flare stacks are situated. Proper adjustment of the gas to the continuous pilot can be obtained by observation of the temperature indicator. It has been found from practice that a properly adjusted pilot light will result in an indicated temperature of approximately 600 F on this instrument.

Further refinements could be added consisting of solenoid switches and valves that would automatically relight the pilot if it should be accidentally extinguished. So far it has not been advantageous to add these further refinements on installations now in use.

The design and construction of this ignition device is covered by patent applications owned by Humble Oil and Refining Company. ***

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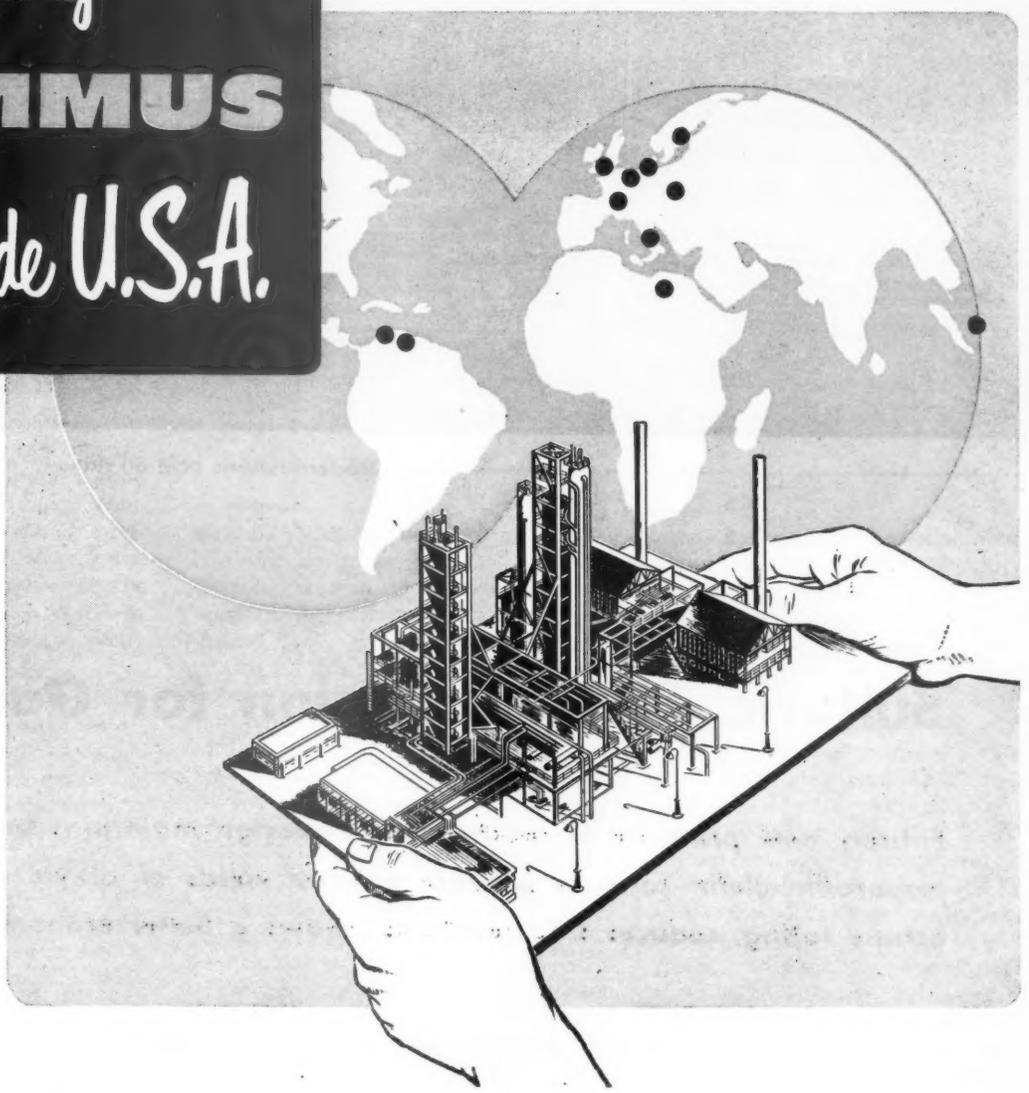

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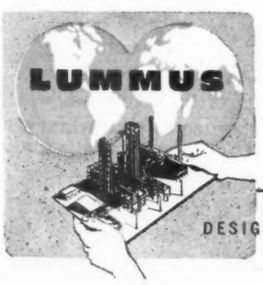

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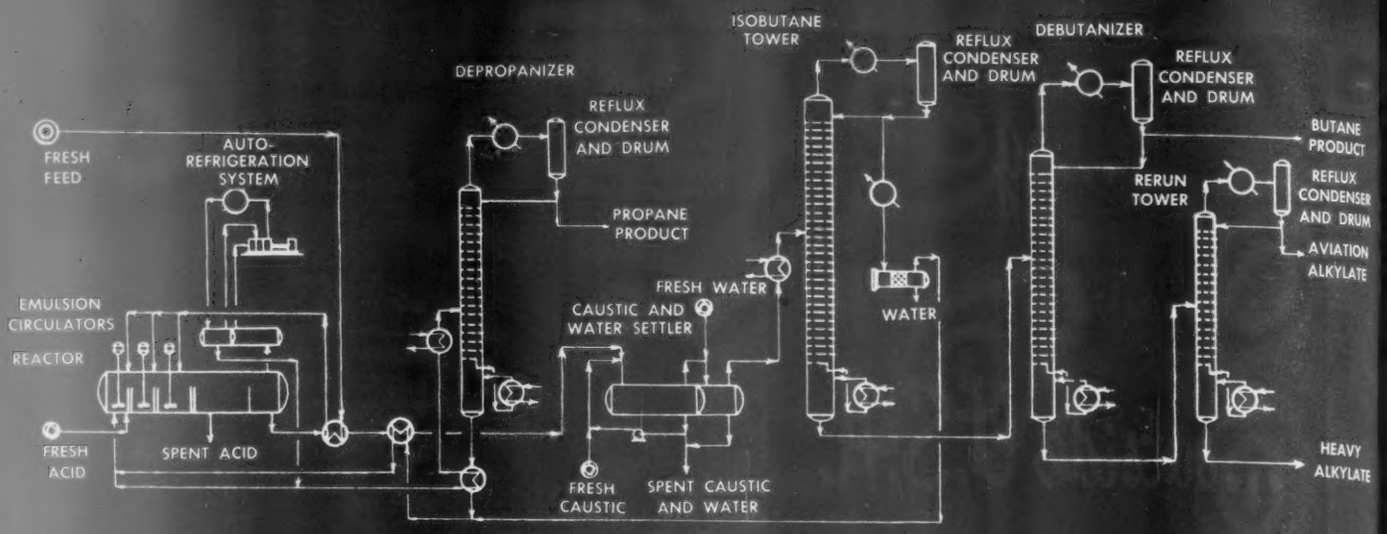


Modern sulfuric acid alkylation. (A simplified flow diagram.)

P 729.71

Sulfuric Acid Alkylation for Gasoline

Entirely new principle of reaction vessel design maintains most efficient isoparaffin-olefin ratio to produce greater yields of alkylate of higher octane rating, reduces side reactions, shows a better economic balance.

J. W. JEWELL, JR.* and C. C. KING*

SULPHURIC acid alkylation of olefins with isobutane has been in commercial operation for almost 15 years. During this period the process has been expanded from operation on butylene only to operation on propylene, butylenes and amylenes, either separately or in mixture. In addition, numerous design improvements have led to greater capacity at no loss of product quality on existing units and lower initial investments for new plants.

Today alkylation stands as an economically attractive process for the production of high octane blending materials for motor gasoline and as a prime requisite for the production of aviation gasoline blending stock. At the start of the last war alkylation was a new process in small commercial production. During the war alkylation capacity was expanded to about 150,000 bbl per day to meet the needs of wartime demand for aviation gasoline. Immediately after the war a large portion of this capacity was shut down due partly to a shortage of butanes brought about by the conversion of cracking facilities to a peacetime basis and partly to a preference on the part of many refiners for catalytic polymerization. Some time before the present international crisis developed, however, and in the face of constantly rising motor gasoline octanes, refiners began again to seriously consider the improved sulfuric acid alkylation process and orders were placed with The M. W. Kellogg Company for two units to produce motor gasoline blending stocks. Since the commencement of the Korean situation, midway through last year, refiners have been renovating and expanding existing alkylation units and adding rerun equipment in order to again produce aviation blending stocks. More recently the projected aviation gasoline requirements have turned the processing spotlight fully upon the need for more alkylation capacity.

Fig. I shows the flow sheet of a modern alkylation unit. Briefly the flow is as follows: Fresh feed from storage is heat exchanged against the reactor effluent and then divided between the various reaction zones. Fresh acid and isobutane are introduced into the final reaction zone. After passing through the reaction zones the acid is settled out and withdrawn from the reactor. The hydrocarbon effluent, consisting of alkylate and isobutane recycle, after heat exchange is caustic and water washed to neutralize any residual acidity. The isobutane recycle is then fractionated from the alkylate and normal butane in the isobutane tower following which the alkylate is debutanized. Finally, in an aviation operation, the

*M. W. Kellogg Company.

TABLE 1

	C_3	C_4	C_5
Olefin feed			
Isobutane requirement Vol. % on Olefins	132	115	112
Alkylate yield Vol. % on Olefins	178	172	155
Octanes-aviation alkylate ASTM octane No. clear	90	94	91
F-3 or 1-C octane No. + 4.6 cc TEL	106	108	107
F-4 or 3-C blending index No. + 4.6 cc TEL	140–145	155–160	145–150

alkylate is rerun to meet the end point specification for aviation blending stock.

Refrigeration for maintaining the reaction temperature is supplied by vaporization of light hydrocarbons in the reactor. These vapors are withdrawn, compressed, condensed, and returned to the reactor. In recent designs centrifugal compressors have been used for the refrigeration system, working out well both from the standpoint of low first cost and a good utility balance. The centrifugal compressor may be driven by high pressure non-condensing steam and the exhaust steam used for reboiling the isobutane tower; or, it may be driven by power when high pressure steam is not available.

The compressor condensate is concentrated in propane, so that a portion of this steam is advantageously used for purging propane from the system. The purge is fractionated in a depropanizer, the bottoms product being returned to the reactor.

Typical feed compositions and alkylate yield and quality data, for such a plant, are presented in Table I.

Fundamentally, the alkylation reaction is the combination of olefin molecules with isobutane molecules, resulting in the production of principally C_7, C_8, and C_9 isoparaffins. Control of this reaction, which is catalyzed by sulphuric acid, demands first — an adequate supply of isobutane, and second—excellent contact or mixing of olefins, isobutane and acid. In practice, a considerable excess of isobutane must be present in the mixture, in order to prevent the formation of olefin and acid-olefin polymers. This requirement is fulfilled in plant design by maintaining a recycling supply of isobutane to the reactor. The effectiveness of isobutane/olefin ratio is illustrated in Table II wherein data are shown on butylene alkylation at various ratios in an ordinary single contact reactor.

The mixing of isobutane, olefins and sulfuric acid to effect the alkylation reaction has been carried out in several different types of contacting devices in reactors. The reactor is the heart of the alkylation process and its design may have an effect upon the

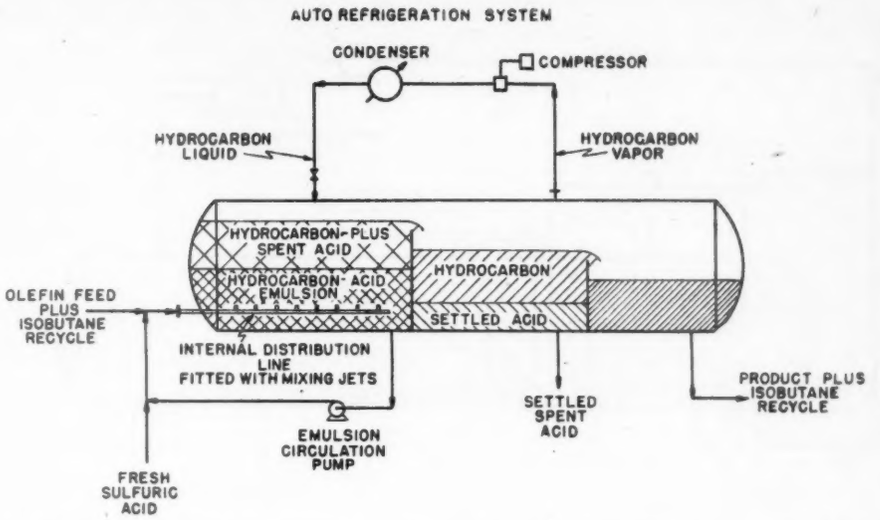


FIG. 2. Sulfuric acid alkylation reactor with external emulsion circulation and auto-refrigeration system.

alkylate yield, and octane number, the consumption of sulfuric acid, and the required recycle rate of isobutane. In most of the plants built by Kellogg during the last war, the reactor included a contacting section with a distributor pipe containing glass jets through which fresh feed, isobutane recycle, and fresh acid are introduced into the reaction zone. (See Fig. 2.) By means of an external circulation system the mixture of acid and hydrocarbon is also circulated through this distributor in order to help maintain an emulsion and to thereby provide the best possible contact between the two phases. The spent acid and effluent hydrocarbons flow over a dam into the settling section of the reactor in which the spent sulfuric acid settles out and is drawn off. The hydrocarbon substantially free of sulfuric acid flows over another dam into a surge section and thence to fractionation.

During the war, Kellogg developed a new cascade mixer reactor design which possesses marked advantages over the older type of reactor (see Fig. 3.) In the new reactor the contact between isobutane, olefin, and sulfuric acid is divided into multiple contacting zones. The reactor illustrated has three separate zones. All of the isobutane recycle and all of the fresh sulfuric acid is introduced into the first reaction zone at the left side of the drawing. The fresh feed containing the olefins is divided into equal portions between all three zones. The flow of acid and hydrocarbon is in cascade from one zone to the next. In this manner the isobutane to olefin ratio entering each reaction zone is maintained at the highest possible level. With a reactor containing three zones and a four to one isobutane to olefin ratio, feeding the reactor as a whole, the isobutane to olefin ratio entering each reaction zone is more than nine to one, as opposed to 4:1 in the old type reactor.

Because of the higher effective isobutane-olefin ratio in the cascade type reactor a lower external isobutane olefin ratio may be used in plant design thus effecting a reduction in size of the isobutane tower and a substanstanial savings in plant and utility costs. Isobutane recycle is well known to be one of the most costly features of alkylation, requiring a large fractionator of normally fifty to sixty-five trays, with attendant reboiling facilities, to separate the isobutane recycle from the normal butane and alkylate. In the case noted a reduction in the external isobutane recycle required to arrive at a 9:1 isobutane to olefin ratio in the reactor, results in a reduction of approximately 50 per cent in the required capacity of the isobutane fractionation facilities.

The foregoing advantages of maintaining a higher effective isobutane olefin ratio, while at the same time the total isobutane in circulation is reduced, are best illustrated by the following operating data taken from a plant now in operation with a cascade reactor containing only two contacting zones. Operating on an olefins mixture of 15 per cent propylene and 85 per cent butylenes, with a reactor

TABLE 2. Butylene Alkylation.

Reactor temperature			35-40F
Spent acid strength			90%
Isobutane/olefin ratio in feed	7:1	5:1	3:1
Yield aviation alkylate (350 E.P.) (Volume % on olefins)	163	160	156
ASTM octane number—clear	93.5	92.5	91.5

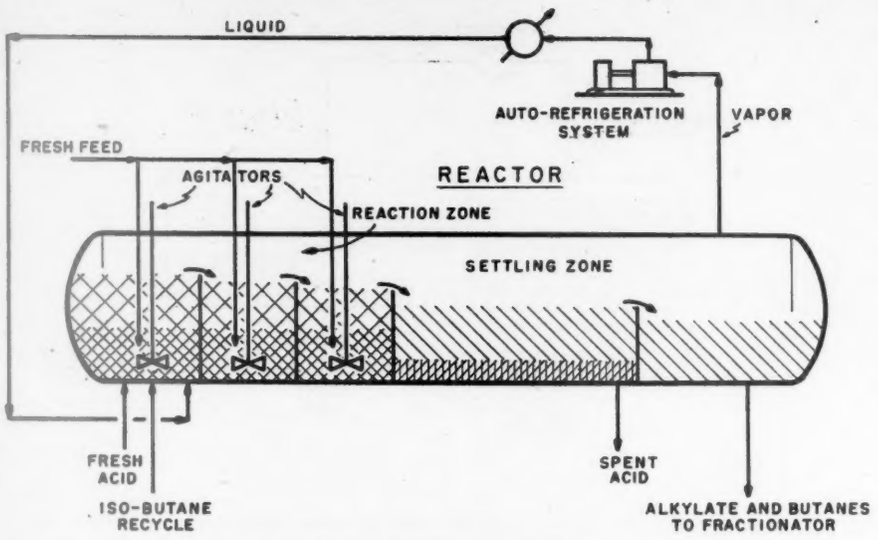


FIG. 3. Sulfuric acid alkylation reactor with internal emulsion circulation and auto-refrigeration system

temperature of 35 F and an overall isobutane olefin ratio of only (3.8) to 1, the clear motor octane of the total alkylate has been varying from 93 to 94. This contrasts with the data on butylene alkylation showing a 92.5 clear motor octane for aviation alkylate at 5 to 1 isobutane olefin ratio.

Another advantage resulting from the cascade mixer reactor is a material reduction in the power requirement for circulating emulsion. In the old jet reactors emulsion is circulated externally by pumps which force the acid-hydrocarbon mixture through the glass jets at a necessarily high pressure drop in order to achieve efficient mixing. In the cascade mixer reactor no such high pressure drop is required. As a consequence, the cascade mixer reactor uses less than 25 per cent of the power requirement of the jet reactor. In addition to the direct power saving on emulsion circulation, the load on the auto refrigeration system is lessened to the degree that the energy put into emulsion circulation constitutes an additional load on the reactor cooling system. The overall result of these effects is a plant power saving of approximately 20 per cent over the jet type installation.

During the alkylation reaction, sulfuric acid undergoes degradation, or loss in acid strength, due to a build-up of organic matter in the acid. Since the alkylate product is affected by the acid strength at the point of reaction, the manner and degree to which degradation is allowed to proceed is important. For example, some data on butylene alkylation, in a single contact type reactor, indicate a drop in alkylate octane rating of two numbers for a decrease in spent acid strength from 92 per cent to 85 per cent. This effect is minimized in the cascade mixer reactor wherein only the acid in the final contacting zone is at the lowest strength as compared to the jet reactor wherein the total acid inventory is at spent acid strength.

The consumption of acid is dependent on a number of factors, principal among which are the nature of olefins being alkylated and the concentrations of acid entering and leaving the reactor. In normal practice fresh white 98 per cent sulfuric acid is charged to an alkylation unit. Some plants with sulfuric acid recovery systems, however, charge an acid to the alkylation reactor of slightly lower strength. The principal effect of this practice is to increase the circulation of sulfuric acid through the reactor and through the recovery system. Other plants utilize spent alkylation acid for treating purposes and consequently withdraw a high strength spent acid. Typical acid consumptions when charging 98 per cent fresh acid and withdrawing 90 per cent spent acid are 2.0 lb acid per gallon of total alkylate for propylene alkylation, 0.6 lb acid per gallon of total alkylate for butylene alkylation and 1.0 lb acid per gallon of total alkylate for amylene akylation. When charging mixture of olefins to an alkylation reactor the acid consumption follows closely an arithmetic average based on the volume per cent of the different olefins in the feed.

Through the years many refiners have examined sulfuric acid alkylation and have balked at the problems of acid procurement and spent acid disposal in situations where chemical plants were not available in the refining area. More recently the growing attractiveness of alkylation for motor gasoline production has stimulated interest in the associated acid problem and has led to the development of several types of small capacity, low cost, acid reconstitution processes. These processes lend themselves readily to literal combination with alkylation units where the situation calls for the refiner to handle his own acid problems. Today's national defense and industrial expansion problems not only serve to point up the value of such processes to the refiner, in the face of an acid shortage and probable allocation, but also emphasize the value of spent acid to the chemical industries.

In principle, the conventional reconstitution processes burn the spent acid to SO_2, employing the contaminating hydrocarbons as fuel, and subsequently through the familiar contact method produce 98-99 per cent water white acid. The small make-up sulfur requirement may be readily supplied by the H_2S available in most, not all, refinery fuel gases, where the reconstitution is undertaken by or adjacent to the refiner. These conventional processes add approximately 50 per cent to the investment for the alkylation plant, in return for which the plant is independent of an outside supply of sulfuric acid.

The Kellogg company is presently completing research and development work upon a radically new process for recovering spent acid which promises to substantially eliminate the investment requirement for this phase of the alkylation process, while reducing the net acid requirement to an insignificant fraction of the current 0.6-2.0 lb per gallon figures.

A particularly interesting and potentially broad application of sulfuric acid alkylation lies in a combined operation with catalytic polymerization. In this combination deethanization is assumed to have taken place in the poly feed prep step, the poly unit depropanizer is operated as a debutanizer and its overhead product, consisting of unconverted C_3 and C_4 olefins plus attendant normal and isoparaffins, becomes the feed stock for the alkylation unit. The poly unit debutanizer becomes idle and available for the debutanization of the alkylate, thereby effecting a first cost saving on the alkylation unit.

The operating conditions on the poly unit are adjusted to obtain an olefin conversion level which will leave the unconverted olefins in the effluent in proper ratio with the isobutane available for alkylation. Decreasing severity (i.e., lower reaction temperature and higher space veloc-

ity) in the poly operation apparently selectively decreases the conversion of butylenes (as a whole) at a more rapid rate than the conversion of propylenes, and provides an olefin supply for alkylation consisting largely of butylenes. Further, the poly operation preferentially converts isobutylene to polymer and isomerizes butane 1 to butene 2 leaving the most desirable C_4 olefin for alkylation feed. In actual commercial operations the poly unit effluent under these conditions has been found to consist of 80-85 per cent butene-2, 15-20 per cent propylene, with traces of butene-1 and isobutylene.

As previously stated, this type of feed stock in commercial operation has resulted in total debutanized alkylate having as ASTM F-2 octane rating of 93-94, and ASTM F-3/F-4 aviation ratings of 107.4/159 on the 320 E.P. aviation cut when operating at design conditions for motor gasoline. The particular plant from which these data were taken operates at relatively high spent acid strength as dictated by subsequent use of the acid. The quality of the alkylate produced from the combined poly-alky operation may be quickly evaluated by comparing the above data with Table I, wherein typical alkylate qualities, for each of the C_3, C_4 and C_5 olefins are separately presented.

For the refiner who currently employs catalytic polymerization only, this combination offers the means of obtaining complete C_3 and C_4 olefin conversion to gasoline and exchange of high vapor pressure isobutane in the refinery gasoline pool for proportionately greater volumes of lower vapor pressure normal butane or casinghead gasoline. These factors alone, aside from the added production of the highest quality blending stock, provide a most attractive economic picture in many refining situations.

The extent to which it is necessary to back off poly conversion in order to provide sufficient olefins to satisfy the available isobutane is, of course, dependent upon the refining conditions prior to cat poly; however, in several commercial situations recently analyzed by Kellogg, a reduction in poly production of approximately 25 volume per cent has been sufficient to supply the olefins required by the isobutane content of the refinery gasoline pool and has resulted in a debutanized alkylate production equivalent to over 80 per cent of the original cat poly production.

The economic aspects of sulfuric acid alkylation, which are presented herein, are based upon the production of motor alkylate in refineries currently including cat poly, and consequently contemplate units without rerunning facilities, and, as previously discussed—without debutanization. The quality of the aviation fraction, which amounts to approximately 95 per cent of the total alkylate, produced under the defined conditions may be considered to be equivalent to typical butylene alkylate having ratings approximating those previously set forth. The question of the economics of aviation alkylate potentially involves the entire refinery processing sequence plus quality trade outs in the gasoline pool. Since these conditions are more or less specific to each refiner, we have not undertaken to present a generalization at this time.

In order to evaluate the position of sulfuric acid alkylation in the motor gasoline production picture, we have prepared economic analyses of refining situations in which alkylation units of 500, 1000, 2500, and 5000 bbl per stream day debutanized alkylate capacity have been included. In each case the conditions, aside from capacity, are precisely the same; the principal point being to emphasize the variation in per barrel operating and investment costs for alkylation and their effects upon payout.

The basic situation away from which these cases have been developed consists of a refinery gasoline pool having a composition and quality before alkylation as set forth in Table 3.

Since by assumption, the feed stock for alkylation is derived from the gasoline pool and the additional blending stocks are extraneous, there is no reason to bring into the evaluations any of the refining conditions prior to catalytic polymerization. As a matter of record, the motor gasoline pool shown in Table 3 represents the result of a processing sequence involving crude topping an M.C. type crude, vacuum flashing, fluid cat cracking, thermal cracking of cat cycle oil and catalytic polymerization. The cat cracker charge amounted to approximately 42 per cent of the crude and the thermal cracking charge consisted of the total cat cycle oil above approximately 55 per cent conversion. Propane and butane recovery amounted to approximately 90 per cent and 95 per cent of production respectively.

In each case alkylate production has been based upon complete alkylation of the isobutane content of the original gasoline pool. In the interests of simplicity the isobutane content of the extraneous butane or casinghead has been ignored. Following alkylation the resulting motor gasoline pools have lower vapor pressure to the extent of (72 lb RVP) isobutane conversion to alkylate. The pools have then been repressured to the original 10 lb RVO level by the addition of either commercial normal butane at 56 lb RVP, or casinghead gasoline at 26 lb RVP.

Table 4 presents the result of the combined "poly-alky" operation and shows the composition and qualities of the final gasoline pools after repressuring with either 26 lb casinghead or normal butane.

Table 5 summarizes the volumes of original, final, and extraneous materials for each case. It is evident from these two tables that the economic incentive for sulfuric acid alkylation lies

TABLE 3. Refinery gasoline components before the addition of sulfuric acid alkylation.

	Vol. %
Debut. cracked and S.R. gaso component	87.5
Debut. cat. poly	6.1
Refinery iC_4+	3.4
Refinery C_4's	3.0
Total refinery gasoline pool	100.0
R.V.P.	10.0
CFR-M (cl.)	68.3
CFR-M+2.0 cc TEL	79.0
CFR-R (cl.)	74.4
cc TEL to 85.0 CFR-R	2.0

TABLE 4

Extraneous blending stock	Butane	Casing-head
Debut. cracked and S.R. gaso. component (Vol. % orig. pool)	87.5	87.5
Debut. cat. poly. (Vol. % orig. pool)	4.5	4.5
Debut. Alkylate (Vol. % orig. pool)	5.0	5.0
Inspections:		
R.V.P.	3.0	3.0
CFR-M (cl.)	93.0	93.0
CFR-M + 2.0 cc TEL	104.0	104.0
CFR-R (cl.)	93.0	93.0
CFR-R + 2.0 cc TEL	104.0	104.0
Refinery C_4's (Vol. % orig. pool)	3.0	3.0
Extraneous blending stock (Vol. % orig. pool)	4.2	13.3
Inspections:		
R.V.P.	56	26
CFR-M (cl.)	92	78.5
CFR-M + 2.0 cc TEL	102	90.2
CFR-R (cl.)	95	8.8
CFR-R + 2.0 cc TEL	104	91.8
Total gasoline pool (Vol. % orig. pool)	104.2	113.3
Inspections:		
R.V.P.	10.0	10.0
CFR-M (cl.)	69.0	69.3
CFR-M + 2.0 cc TEL	79.9	80.3
CFR-R (cl.)	74.9	74.9
CC TEL to 85.0 CFR-R	1.8	1.8

TABLE 5. Barrel summary of refinery gasoline pools.

	1 BPSD	2 BPSD	3 BPSD	4 BPSD
Alkylation production	500	1000	2500	5000
Total refinery gaso. with: max. cat. poly. no alkylation	10,000	20,000	50,000	100,000
Cat. poly. plus alkylation and extrn. N-Butanes	10,416	20,831	52,078	104,160
Cat. poly. plus alkylation and extrn. 26 lb RVP casinghead	11,335	22,670	56,675	113,350

TABLE 6. Typical gulf coast price structure.

Motor gasoline	11.25c per gal
Butanes	4.0c per gal
26 lb RVP casinghead	5.5c per gal
Fuel gas (F.O.E.)	.60c per bbl
H.P. steam	.24c per M lb
Cooling water	.8c per M gal
Power	.75c per KWH
Caustic	3.35c per lb
TEA	26c per lb
98% sulfuric acid	$21.00 per ton
Spent sulfuric acid	$ 8.00 per ton
Labor (Inc. P.B. & S.)	$58.00 per man day
TEL	.23c per cc

in either the combination of TEL savings and butane upgrading, when butane is available, or in the upgrading of casinghead where it is available.

These operations have been evaluated on a Gulf Coast product, manpower, and utility price structure as set forth in Table 6.

The direct operating costs for the various sized sulfuric acid alkylation units are separately summarized in Table 7.

In this instance the costs are shown in terms of cents per barrel against the various debit accounts, rather than as detailed costs for steam, power, etc., in view of the fact that the utility requirements are flexible and may be broadly interchanged to fit the individual refinery problem.

It will be noted that sulfuric acid has been charged against the operations at a net cost of $13 per ton as compared to a current market price of approximately $21 per ton. This net figure contemplates a separate conventional reconstitution operation which at a 20 ton per day capacity costs approximately $6.5 per ton to operate. Of this amount approximately 65 per cent is labor which remains fixed as the capacity rises. Allowing double the operating cost against fixed charges and ignoring the effects of larger capacity, a figure of $8 per ton has been estimated as the value of 88-91 per cent spent acid. In view of Kellogg's progress toward a simplified acid recovery system, this figure—and resultant 25 cents per bbl acid charge against alkylation—may be considered as extremely conservative. *Preliminary figures* indicate potential *elimination* of the *acid charge* as a *significant factor* in the operating cost of sulfuric acid alkylation.

Briefly summarizing the overall economics, from Table 8, sulfuric acid alkylation installations of from 5000 to 500 bbl per stream day capacity payout (i.e., earn their investment cost) in from only three to nine months basis purchase of 26 lb casinghead blending stock at 5.5 cents per gallon. When normal butane is purchased at 4.0 cents per gallon, these same alkylation units pay out in from 0.7-2.9 years. In the latter cases the payout may be materially improved if the extra butane represents additional butane recovery from refinery fuel gas.

If the capital cost of conventional acid reconstitution is included with the investment for sulfuric acid alkylation, and a combined operation is undertaken allowing due credit for the further reduction in net acid cost, the range of payouts for the total investments rise to 0.36-1.10 years when buying casinghead and 1.0-3.75 years when buying butane.

In conclusion, it should be noted that the economic attractiveness of alkylation, in any refining picture, is a function of the availability and qualities of isobutane, olefins, and blending stock. The presence of a catalytic cracking unit alone affords the refiner wide flexibility in the control of both production and ratio of isobutane and olefins. The refining situation presented herein included no naphtha processing. Here again a wide variety of processes and processing conditions, available in many refineries, offers an additional and flexible source of isobutane and olefins. In practice the isobutane content of extraneous casinghead or butanes would often be available as additional alkylation feed stock. All of these factors can serve to increase the production ratio of alkylate to motor gasoline, over the general picture presented, and consequently can serve to improve the economic advantage for alkylation.

Actually the refining conditions upon which we have based the foregoing economics are relatively unfavorable. The production of both olefins and isobutane is substantially minimum and neither normal butane nor 26 lb casinghead are as attractive blending stocks, economically speaking, as 16-20 lb casinghead. Furthermore we have ignored the operating cost savings in the catalytic polymerization unit due to decreasing its severity of operation. Commercial operations have indicated to date that poly catalyst life may be doubled or better by a reduction in the severity of the magnitude required for the combined operation.

Aside from the contemplated use of the poly unit debutanizer in alkylate service, the alkylation units represented herein are independent units. Still greater economy both in first cost and operating cost is available through the design and construction of alkylation units in combination with light-ends recovery facilities and/or cat poly.

The combined effects of these conditions, coupled with the general economic conclusions presented, and our progress toward freedom from both large net acid costs and requirements, indicate a position of economic advantage for sulfuric acid alkylation which merits the serious consideration of every refiner. * * *

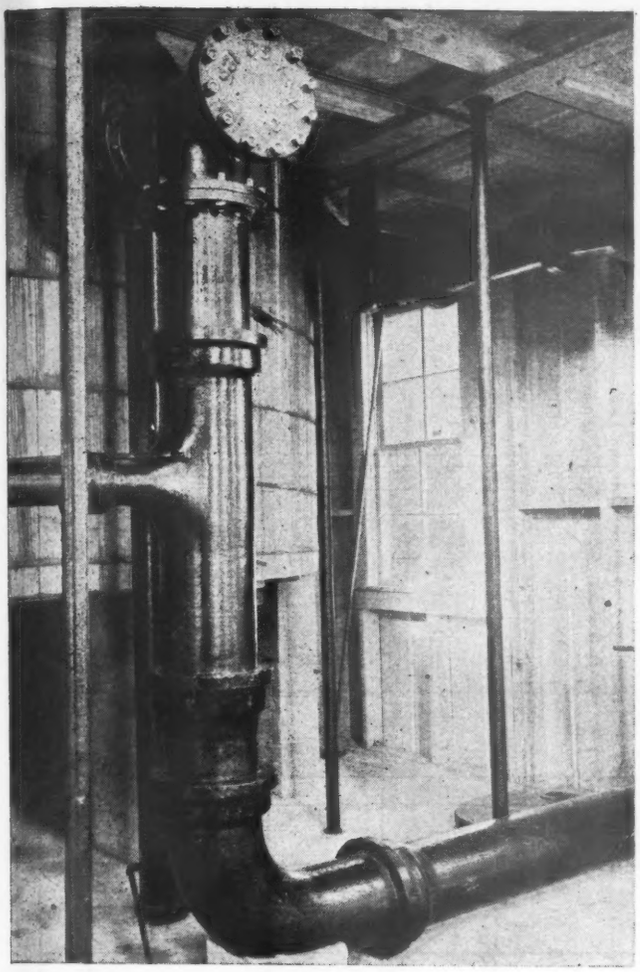
TABLE 7. Summary of direct operating cost of sulfuric acid alkylation units. (Gulf Coast price structure.)

Alkylation capacity BPSD		500	1000	2500	5000
Operating labor	cents per bbl	38.7	19.3	7.7	3.9
Chemicals and utilities	cents per bbl	26.7	26.7	26.7	26.7
Sulfuric acid	cents per bbl	25.3	25.3	25.3	25.3
Maintenance	cents per bbl	9.1	6.1	4.3	3.4
Royalty	cents per bbl	15.0	15.0	15.0	15.0
Total		114.8	92.4	79.0	74.3

TABLE 8. Overall economic summary—Gulf Coast. (Basis 328 operating days per annum.)

Sulfuric acid alkylation for motor and aviation gasoline.

Case number	1		2		3		4	
Alkylation unit capacity	500		1000		2500		5000	
Extraneous stock	Butane $/CD	Casinghead $/CD	Butane $/CD	Casinghead $/CD	Butane $/CD	Casinghead $/CD	Butane $/CD	Casinghead $/CD
Credits — Incremental above base gasoline pool	1,767	5,679	3,534	11,354	8,836	28,388	17,690	56,771
Debits — Incremental above base gasoline pool —								
Butane	628	.....	1,255	.....	3,138	.....	6,283	.....
Casinghead	.....	2,774	.....	5,549	.....	13,872	.....	27,743
Operating cost	517	517	832	832	1,778	1,778	3,344	3,344
TEL	(—109)	35	(—218)	70	(—544)	175	(—1088)	350
Fixed charges (10% of investment)	164	164	220	220	383	383	603	603
Total incremental debits (Before deprn.)	1,200	3,490	2,089	6,671	4,755	16,208	9,142	32,040
Net incremental credits (Before deprn.) $/CD	567	2,189	1,445	4,683	4,081	12,180	8,548	24,731
Net incremental credits (Before deprn.) $/ Yr.	207,000	799,000	527,400	1,709,300	1,489,600	4,445,700	3,120,000	9,026,800
Approximate investment $/BPSD alkylate	1,200	1,200	800	800	560	560	440	440
Payout on investment-years	2.9	0.75	1.52	0.47	0.94	0.31	0.70	0.24



DIRECT ROUTE TO LOWER PLANT MAINTENANCE

The direct and indirect expense of replacements of short-lived refinery pipe lines can be reduced, or avoided altogether, by the use of cast iron pipe. This has been proved by many refineries whose maintenance costs have been lowered by replacing other pipe materials with cast iron.

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Thomas F. Wolfe, Engineer,
1015 Peoples Gas Bldg., Chicago 3, Illinois.

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The Technical Forum

Blending To Vapor Pressure

Q **Show how to calculate the Reid Vapor pressure of a blend of natural gasoline of any assumed vapor pressure, with a refinery motor fuel stock of any assumed vapor pressure, the vapor pressure of the blend to be within standard maximum pressures for winter or summer. (2) How much butane should be added to a refinery gasoline of 9.2 lb Reid Vapor pressure to raise the pressure to 12 lb—at the refinery? Assume typical butane vapor pressure for a commercial butane product with typical amounts of pentane.**

M. G. S.

A The customary method of calculating the true vapor pressure of blends of hydrocarbons is based on Raoults law. That is the partial pressure, p developed by each hydrocarbon is equal to the vapor pressure, P, of the hydrocarbon at the temperature of the system times its mol fraction, x, in the blend.

$$p = Px$$

The total pressure, π, may be calculated by summing the partial pressures.

$$\pi = \Sigma p = \Sigma Px$$

This method is accurate when true vapor pressures are used, but it is not accurate for Reid vapor pressures. This apparent discrepancy occurs because vaporization of some of the light components from any mixture of hydrocarbons occurs during the Reid test. This vaporization produces an indicated or Reid vapor pressure that is about 90 to 95 per cent of the true vapor pressure. In order to obtain Reid vapor pressure, true (or initial) vapor pressure is first computed and a correction applied. Charts similar to Fig. 1 are available to correlate the two pressures.

In order to calculate the mol frac-

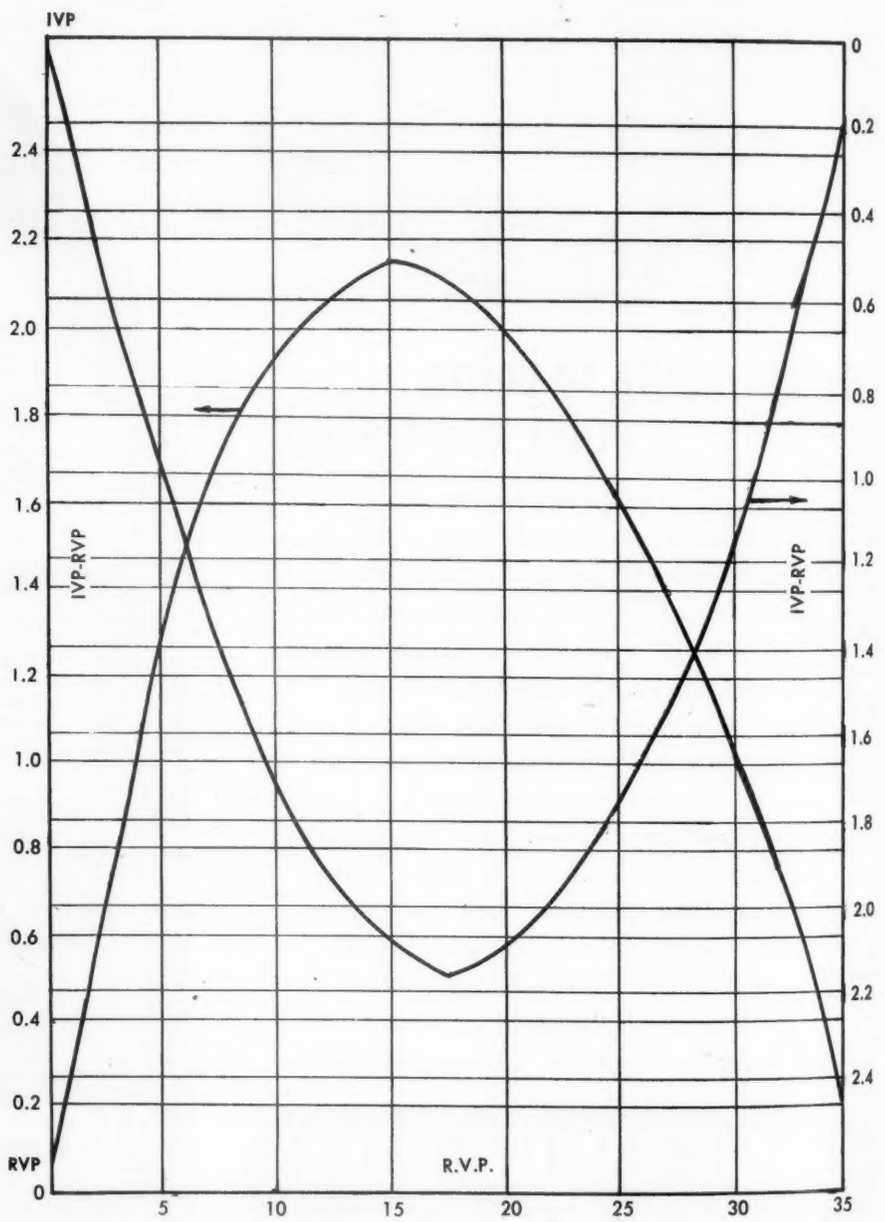
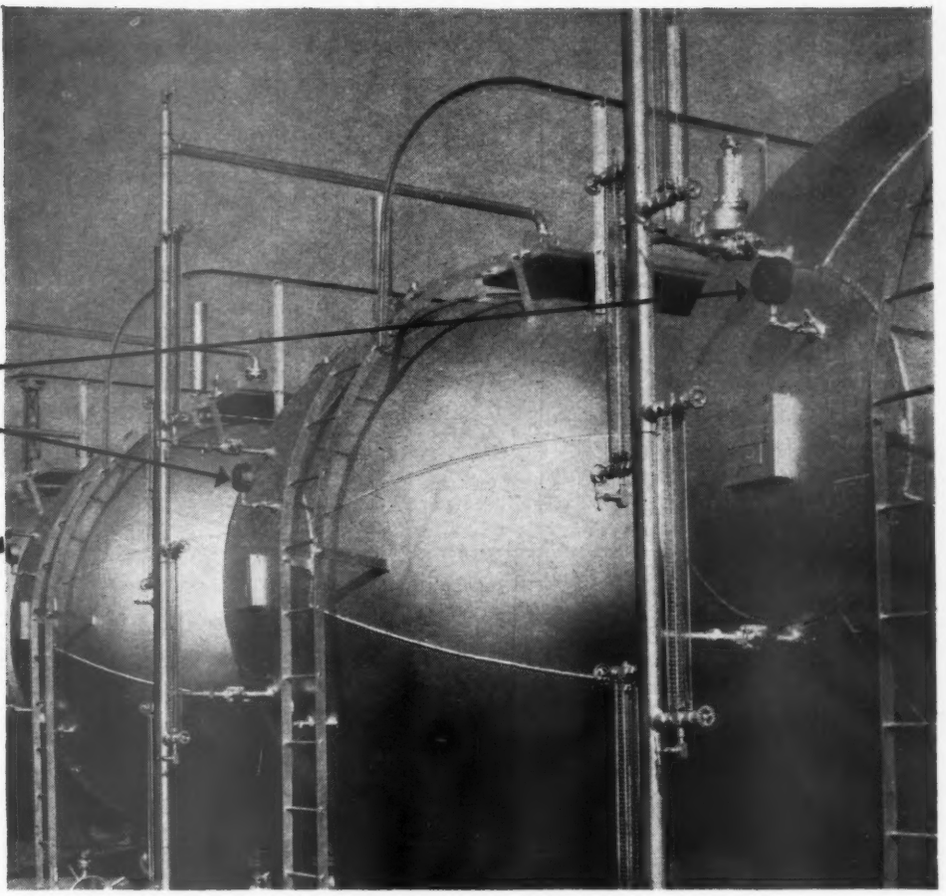


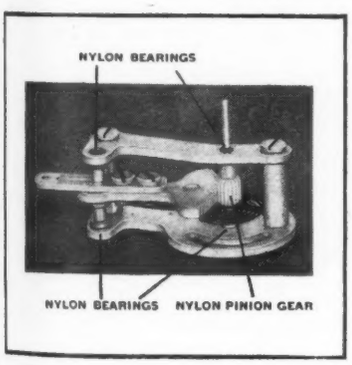
FIG. 1. REID VS. INITIAL VAPOR PRESSURE.

DURAGAUGE SPECIFIED!

Ashcroft Duragauges installed on spherical propane storage tanks at Carthage, Texas.



DURAGAUGE *Nylon Movement** OUTWEARS ALL OTHERS!



How to increase *wear resistance* in a pressure gauge was a stubborn problem—until Ashcroft engineers solved it. Now *only* the Duragauge has a Nylon Movement, *the movement that outwore all others* in extensive laboratory and field tests on the worst services to be found.

Ashcroft engineers recognized the value of lightness and the other characteristics of nylon and anodized aluminum and designed these materials into precision mating parts for the Duragauge. Result: low friction, high impact absorption, corrosion resistance and freedom from objectionable products of wear. Furthermore, the nylon pinion gear and bearings retain their precise form and shape under high temperatures. Consequently, the Nylon Movement provides greatly improved indication sensitivity and accuracy and longer life.

The Ashcroft Duragauge, with Nylon Movement, has proved its enduring dependability in new and old refineries, chemical plants and power stations. It is the unqualified standard for the most "killing" services.

Your Ashcroft Distributor will gladly give you complete facts about the Duragauge and how it can solve your pressure indicating problem.

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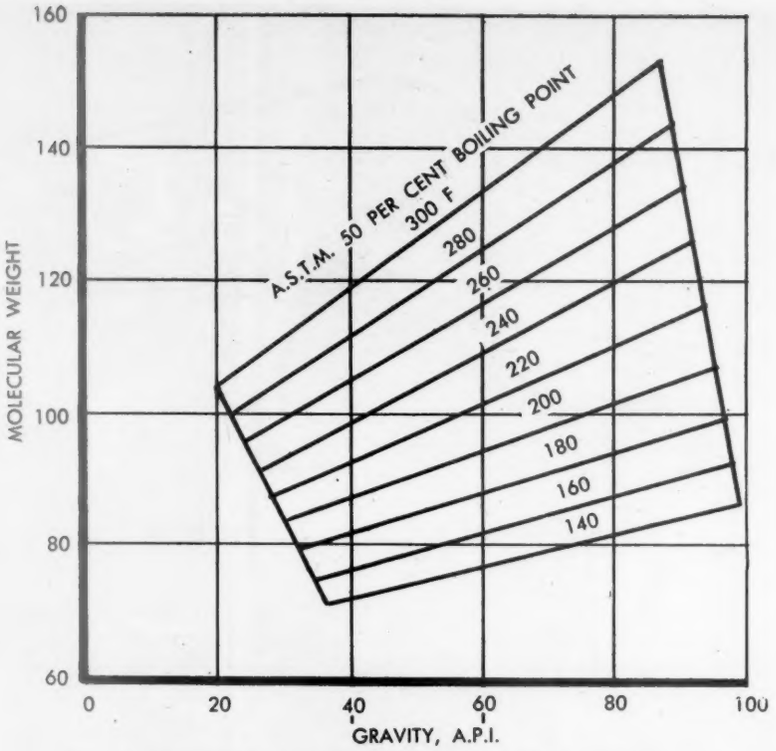

FIG. 2. MOLECULAR WEIGHT OF PETROLEUM FRACTIONS FROM API GRAVITY AND ASTM 50 PER CENT POINT.

tions, it will be noted that it is necessary to know the average molecular weight of the particular mixture of hydrocarbons being used. A good approximation of the average molecular weight may be obtained from Fig. 2. This graph indicates molecular weight as a function of ASTM 50 per cent boiling point and of the API gravity of the mixture.

When calculating the relative amounts of two gasoline stocks for blending to the proper Reid vapor pressure, it is necessary first to convert the Reid vapor pressure of each stock to true vapor pressure. The true vapor pressure of the blend is then calculated, and this pressure is converted to Reid vapor pressure.

The following example indicates the correct method of calculating the Reid vapor pressure of a blend of natural gasoline of any assumed vapor pressure with a refinery motor fuel of any assumed vapor pressure.

Example 1:

It is desired to blend natural gasoline of 18 RVP, 72 API, (ASTM 50 per cent point = 175 F) with refinery gasoline of 6.0 RVP, 58 API, (ASTM 50 per cent point = 240 F) to give an RVP of 11.5 in the finished blend.

	RVP*	IVP*	ASTM 50% Pt
Natural gasoline	18.0	20.09	175F
Refinery gasoline	6.0	7.42	240F
Blend	11.5	13.57	

* Interrelationships from Fig 1.

	Vol gal.	Density °API	#/gal	Weight lb	MW**	Mols
Nat gas	×	72	5.788	5.788×	90	0.06431×
Ref gas	100	58	6.216	621.6	108	5.7556

** Obtained from Figure 2, using ASTM 50% Point and °API gravity.

Applying $\pi = \Sigma Px$.

$$13.57 = 20.09 \times 0.0643 \times^{1} + \frac{7.42 \times 5.7556}{0.06431 \times + 5.7556}$$

$$\times = \frac{34.41 \text{ gal Nat. gasoline}}{100 \text{ gal. Ref. gasoline}}$$

The following example indicates the amount of butane that should be added to a refinery gasoline of 9.2 lb Reid vapor pressure to raise the pressure to 12 lb.

Example 2:

	RVP	IVP	ASTM 50 percent Point
Butane	—	52	—
Refinery gasoline	9.2	11.07	240
Blend	12.0	14.09	

	Vol gal	°API	Density #/gal	#	MW	mol frac.
Butane	×	—	4.863	4.863×	58	0.08384×
Ref gas	100	60	6.135	613.50	109	5.628

$$\pi = \Sigma Px$$

$$14.09 = 52 \times 0.08384 \times + 11.07 \times 5.628$$

$$0.08384 \times + 5.628$$

$$\times = \frac{5.35 \text{ gal. butane}}{100 \text{ gal. Ref. gasoline}}$$

G. L. Farrar
A. M. Platt.

Ammonia Synthesis

Q We are considering using part of the gases coming out of a 45,000-bbl day refinery to make ammonia and products useful as fertilizers. The above mentioned gases are made of CH_4 (45 per cent), H_2 (10 per cent), C_2H_6, C_2H_4 and C_{3s}.

We would like to have answers to the following questions: Considering production of ammonia from refinery gases, in your opinion which is the more efficient process, the widely known steam-methane or the partial combustion of refinery tail gases in an oxygen atmosphere. (Hydrocarbon Research Inc. patent)? Which is the more easily operated process? What are the essential steps in each case? What catalysts are employed?

A The preparation of the ammonia synthesis gas mixture containing $3H_2$:N_2 from natural gas or refinery gas can be accomplished in two ways. The first is the steam-methane reforming reaction (1) over a nickle catalyst at about 1350 F followed by a cleanup reforming in which the gases from the first stage reformer are mixed with air or flue gas (for nitrogen) and passed through a second reformer at 1650 F, also with nickel catalyst. These gases then pass to the water gas shift unit employing reaction (2) over an iron catalyst at 1000 F. These reactions follow:

(1) $CH_4 + H_2O = CO + 3H_2$
—(Reforming reaction)

(2) $CO + H_2O = CO_2 + H_2$
—(Water gas reaction)

(3) $CH_4 + 2H_2O = CO_2 + 4H_2$
—(Overall reaction)

The gas mixture from reaction (2) has approximately this composition:

Component	Mol per cent
H_2	60
N_2	21
CO_2	15
CO	3
CH_4	1

This gas is compressed to several hundred pounds gage and water-scrubbed under pressure for carbon dioxide removal, which is practically complete. The gas is further compressed in multi-stage compressors with inter-stage cooling to about 1600 psig. It is then scrubbed with refrigerated copper-ammonium formate liquor for carbon monoxide removal, caustic washed and then compressed to the synthesis pressure of about 4500 psig.

The above operations all assume a sweet gas. With higher sulfur con-

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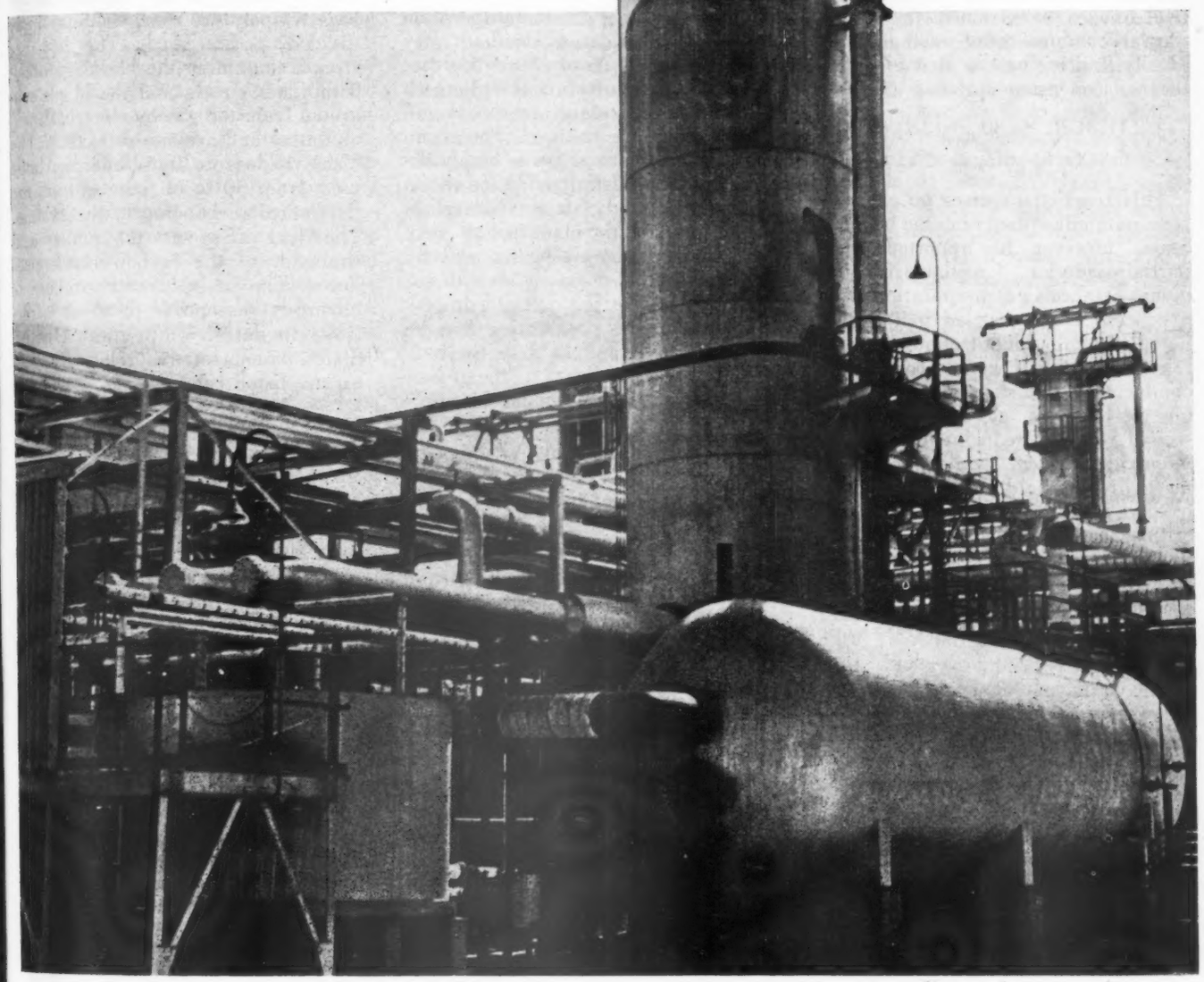
assures these money-saving advantages

- Low installation costs
- Low operating costs
- Effective salt removal
- Periodic servicing
- Continuing research

CHEMICAL DESALTING



HIGH EFFICIENCY

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In many of America's leading refineries Tretolite desalting is delivering salt removals as high as 90 to 95%. The low water requirement seldom exceeds 5 to 8% of the total volume of the crude charge. Tretolite desalters now in use range in capacity from 2,000 to 50,000 barrels per day per plant, since Tretolite desalting is adaptable to either large or small refining operations. Periodic checking by Tretolite desalting engineers insures that your Tretolite desalting process stays at top operating efficiency.

The recognized economy of Tretolite desalting is due to the high flexibility of the process. This process flexibility often permits the use of existing refinery equipment as part of the desalting installation, obviously holding installation costs at a minimum. This low installation cost, plus the low water, heat and chemical requirements, helps to hold Tretolite desalting cost per barrel at a minimum.

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tents provision must be made for sulfur removal in order to avoid poisoning the nickel reforming catalyst with an attendant high methane content in the finished synthesis gas. High methane in the synthesis gas to the ammonia converters leads to relatively large gas losses in purging methane and argon from the system and hence lower ammonia yields on gas and lower production from the plant.

The second ammonia gas process basically rests on the use of industrial oxygen or enriched air for the partial combustion of methane. An ideally limiting case is that given by the reaction using enriched air

$$(4)\ 3CH_4 + 3O_2 + 2N_2 = 3CO_2 + 6H_2 + 2N_2$$

This reaction requires no catalyst. No ammonia plant in the United States, however, has reported using partial oxidation of methane for ammonia synthesis gas preparation. It is a process as yet untried in industry here though no doubt technically feasible. In practice it would probably be conducted in two steps to take advantage of the water gas reaction in the second step for reducing the carbon monoxide content while increasing the hydrogen yield. Economically the oxygen plant investment may be the critical factor for scrutiny in comparing the two processes. Today in the United States a plant to produce 100 tons of industrial (95 per cent) oxygen will cost about $1,500,000 with a corresponding oxygen cost of approximately $7.50 per ton of oxygen. Equation 4 indicates a theoretical oxygen requirement of 1.41 tons of oxygen per ton of ammonia or a corresponding oxygen cost of around $10.60 per ton of ammonia. In order to compute a realistic economic comparison additional data are needed including the desired ammonia capacity and the value and sulfur content and quantity of refinery gas available for this purpose.

In a very large ammonia operation the partial oxidation method may prove to be the more economical but the scale of manufacture must be such that the oxygen plant investment and maintenance are justified. The steam reforming of natural gas is highly developed. The partial oxidation method is in its early stage of development. If ammonia manufacture were the primary manufacturing activity the troubles that normally go with undertaking a relatively untried process for ammonia gas preparation may be justified but if ammonia synthesis is regarded as secondary then the proven trouble-free process should be preferable.

Dr. James H. Boyd.

Carbon Black From Heavy Oils

Q **Please send us information concerning the process used in converting heavy fuel oil to carbon black.**
G. J.

A Carbon blacks for use in rubber from heavy hydrocarbon oils are made by the so-called furnace processes. These oils are believed to be entirely distillates. In this general type of operation a high temperature is maintained with a high degree of gas turbulence in a retort or furnace by the combustion of air with natural gas and hydrocarbon vapors or vaporizable liquids. Oil vapor or finely divided liquid in excess of the combustion requirements decomposes in the high temperature zone yielding finely divided carbon black. The hot gas stream containing the black is cooled with water sprays and the black separated from the gas by electrical precipitators and cyclone collectors. The black yields from liquid hydrocarbons vary from 30 to 60 per cent of the theoretical carbon fed to the system. The yield varies with the quality and character of the carbon black produced. The basic furnace process is obviously susceptible to great variations in detail. Important United States patents in this relatively new art are listed below:

J. W. Ayers	J. C. Krejci	Hanson-Skoog, Grisso
2,420,999	2,419,565	2,413,586
2,202,355	2,375,978	2,368,828
Re. 22,886	2,375,977	2,368,827
	2,375,976	
	2,375,975	

Dr. J. H. Boyd.

WANTED: A BETTER DEFINITION FOR "FRICTION"

By W. F. SCHAPHORST

HERE is a statement concerning power transmission through belting that the writer found in a prominent engineering journal some time ago and considers untrue: "Some slip is necessary, since without it there is no friction between the pulley and belt and no power can be transmitted."

The statement caused the writer to do some thinking and searching, and he has come to the conclusion that the cause of the erroneous statement is doubtless due to the usual text book and dictionary definitions of the word "friction." Avery, in his Elementary Physics says: "Friction is the resistance that a moving body meets from the surface on which it moves." Nichols and Franklin say this: "A body in motion is always acted upon by dragging forces which oppose the motion and tend to bring the body to rest. This action is called friction." Webster says it is "a force acting in the tangent planes of two bodies, when one slides or rolls upon another." And Funk and Wagnalls say it is, "resistance to motion due to the contact of surfaces." From the writer's viewpoint the Funk and Wagnalls definition is the correct one because it does not specify that the surfaces must be in motion for friction to exist.

For example, a man may be standing on the extreme edge of a sloping roof but he is *not* slipping. Friction between his shoes and the roof enables him to remain in that position. If he chooses he can turn around and climb the roof, and unless the roof is too steep, he will not slip. If it is not friction that enables the man to stand there and then climb the roof at will, what is it? Slip, therefore, from this writer's viewpoint, is *not* necessary in order that power may be transmitted, only contact betwen a belt and a pulley. There is a difference in the *kind* of power being transmitted or conveyed in the two instances, but, nevertheless, the fact remains that slip between a belt and pulley is not *necessary* for the transmission of power although, admittedly, slip commonly does exist. Slip exists in many drives because the belt is not wide enough, the pulley is not sufficiently large in diameter, the belt is of inferior quality, or it is not given proper care, etc. If the drive is properly designed and cared for there will be no slip whatever.

Returning to the above definitions of the word "friction," it is the writer's suggestion that we develop a better one than any thus far presented. Here is one that the writer thinks is more exact: "Friction is the resistance to motion that an unattached body meets from the contacting surface or surfaces past which it moves or tends to move." Can you suggest a better one?

What the writer wants to bring out plainly is the fact that motion is *not* necessary before we can have frictional forces. The man on the edge of the roof is held there by a "frictional grip," by "frictional resistance," by "friction of repose," or by "static friction," call it what one will, but there *is no slip*, and there *is no motion*. * * *

Capacity Expansion Main Job of Refining Industry

ARCH L. FOSTER*

EXPANSION of our basic refining capacity is the most important item on the agenda of the petroleum refining industry in the United States, according to statements and implications by Bruce Brown, deputy chief of the Petroleum Administration for Defense (PAD), before the Western Petroleum Refiners Association, at its 39th annual meeting in San Antonio, April 2-4. The prospect for the refining industry and the accomplishments to be required of it in our defense program were outlined in frank detail by Brown, Reid Brazell, the head of PAD's Refining Division, and others who spoke before the more than 1000 refiners.

In view of the fact that catalytic cracking, once too expensive for any except the largest refining organizations, has been reduced in cost to meet the limitations of finance which are controlling the actions of the smaller refiners, the most important bottleneck in the refiner's picture is that of alkylation units in small capacities that will not be too expensive for these same small refiners. With the prospect that the aviation gasoline (military) demand for the last half of 1951 will be 30 to 35 per cent greater than the first half-year requirement, jet fuels 20 to 30 per cent more, the industry has its work cut out for it, prefabricated to order.

"All refiners, then, large and small," said Reid Brazell to the Western Refiners, "can contribute greatly to the mobilization program by planning to expand their basic refining capacity." Brown designated the expression "basic refining capacity", as meaning not capacity for specific defense products but capacity that can convert crude petroleum into its basic commercial products—gasoline, kerosine, asphalt, lubricants, wax, etc.—which are required by our peacetime economy and from these products or byproducts the specialized processes draw their raw or intermediate charge stocks.

Of timely interest was the presentation by J. W. Jewell and C. C. King of the M. W. Kellogg Company, of an article giving technology and economics of a very importantly revised sulfuric acid alkylation process. This process was the first to appear on the commercial scene prior to World War II as a means of combining isoparaffins and olefins of low molecular weight to form high octane rating aviation fuel blending stock, with clear octane numbers above 90 Research. One drawback was the problem of recovering the spent acid in a form useful either for further use as alkylation catalyst or for other refining purposes, a solution for which has been developed long since. A second problem has been that of maintaining the proper ratio between isoparaffin and olefin content in the reaction zone, whereby both yield and alkylate quality may be controlled at high levels.

This last problem has been solved by the Kellogg company in a unique manner. In a horizontal type reactor having five compartments separated by vertical baffles or weirs, separate streams of the same acid-isoparaffin-olefin mixture are introduced into each of three parallel reaction zones. Simultaneously a separate stream of isoparaffin makeup and recycle stock is introduced into each of these zones, in which the entire mix is agitated by mechanical means to insure intimate contact between the two main components and the catalyst. The reaction mixture including newly formed alkylate, the remains of the olefin charge, the catalyst and the excess isoparaffin overflows into the next zone, which means that the excess isoparaffin is added to that mixture to maintain the isoparaffin-olefin ratio. The same operation carries the excess from this second section into the third, and through this system the reactant ratio is maintained at any desired value throughout the three sections, rather than to have it become progressively less as the mixture passes through the system. Spent acid settles out in the larger, settling section and is withdrawn. Alkylate and unreacted components overflow into the end or withdrawal zone, or led to a fractionator where lighter components, isoparaffin and olefin, if any of the latter remain unreacted, are taken off overhead and returned to the reactor along with makeup isoparaffin. In this manner yield and quality of alkylate are raised, as is shown elsewhere in this issue where the detailed article is presented. The economics of this process are still somewhat on the difficult side, especially for smaller capacity units, but have been improved vastly in comparison with wartime unit costs. Further improvement is expected as more and more units are built.

A new type of radiant heater and radiant type burner is employed by Phillips Petroleum Company to attain very high input rates in heating various charge stocks. These Selas-type radiant type burners are spaced at relatively close intervals directly opposite and near to radiant heating coils and individual burners and banks of burners are fired in such manner that, for vis-breaking for example, a straight-line heating curve is obtained. Heat input rates of 30,000 to 40,000 btu per square foot per hour are obtained in the last—highest temperature—coils. In a comparative run to crack, single-pass, catalytic recycle oil in the new furnace and a conventional box furnace, the latter could not attain the cracking rate and per cent conversion reached by the radiant furnace before reaching the coking stage in the box furnace. Gasoline yields of 31 and 28 per cent respectively, were obtained with the radiant furnace, at conversion temperatures of 1025 and 934 F respectively, reported C. C. Tate of Phillips, as compared to 22 per cent for the conventional furnace at 920 F top temperature. Flexibility of temperature control and control of the whole temperature curve is one of the new furnace's outstanding advantages, Tate said.

Commercial applications of the new Texaco Combustion Process to automotive engines will shift emphasis from chemical octane numbers to mechanical octane numbers, said Blake Reynolds of the Texaco Development Corporation. This process includes the compression of ignition air without the presence of fuel during the compression stroke, mechanical injection of fuel a la diesel engine operation, and a flame front ignited by

Socony Refinery Awarded

Of the 298 oil companies participating in the National Safety Council's annual safety contest for the past year, Socony-Vacuum Oil Company's refinery at Paulsboro, New Jersey, was the safest among larger individual refineries in the world. This is the second year in a row that Paulsboro refinery has been in first place.

*Editor, Refining and Gas Processing.

a conventional spark plug, burning the fuel at the essentially same rate as injection rate to avoid the introduction of detonation. This system will enable the engine designer to provide a 30 per cent increase in miles-per-gallon economy over conventional spark-ignition engines. Ability to burn very lean mixtures enables this design to show better part-load efficiency than can the conventional gasoline or Otto cycle engine.

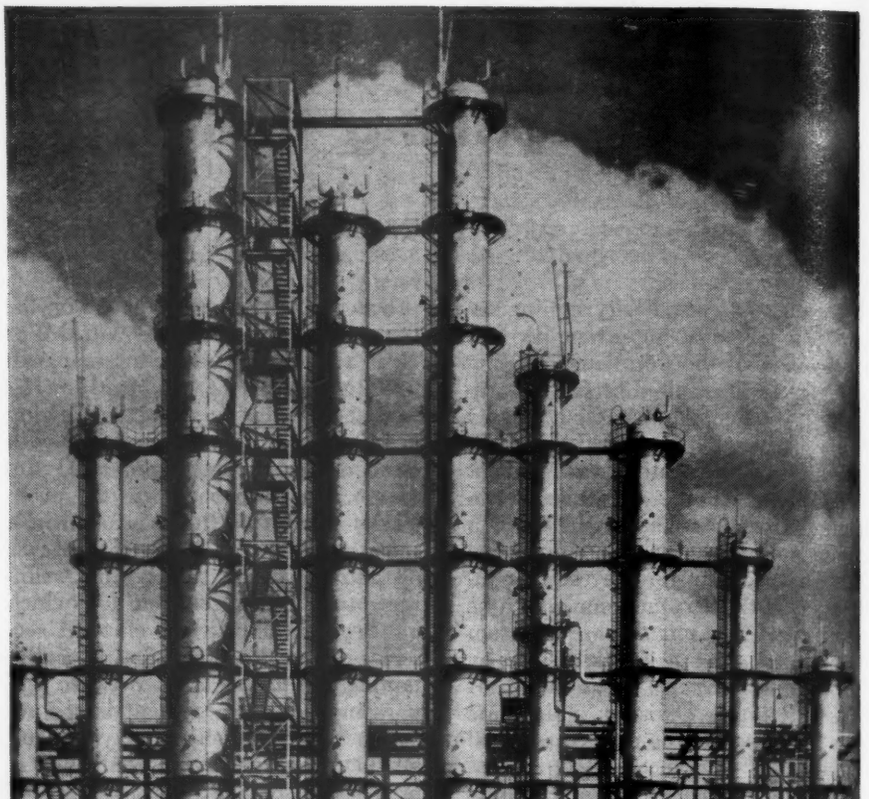
The various catalytic processes which dehydrogenate naphthenes from petroleum sources into aromatics benzene, toluene, etc., make the industry capable of producing the estimated 252 gallons per year of needed benzene if production cost is not the controlling factor, says George Weber, refining editor of *Oil and Gas Journal*, in discussing petrochemical developments in the southwest. Coke oven benzene may increase only from 170 to 190 million gallons, he said, and that industry is working to improve its light oil recovery facilities to raise production. Hydroforming, the Shell benzene process, Platforming, Atlantic's process as well as Socony-Vacuum's new catalytic reforming process, all will add to our aromatic production in case of serious war demands. Production of aliphatic chemicals almost doubled in 1950 over 1945, the respective yields being 15.7 billion lb and 8.8 billion lb. The new Brownsville Hydrocol plant will add large quantities to this gross yield, 150,000,000 lb when and as that plant gets into production.

Reopen Kansas Helium Plant

Reopening of the Bureau of Mines' helium plant at Otis, Kansas, to meet increasing military and industrial requirements for this lightweight, non-inflammable gas was announced recently by James Boyd, director of the Bureau of Mines. The plant, which has a rated capacity of about 48,000,000 cu ft annually, will supplement the production of the helium plant at Exell, Texas.

Built early in World War II, the Otis plant cost about $3,000,000. It was operated until 1945, when the plant was shut down and placed in stand-by condition.

The reactivated plant will employ about 70 persons, including key personnel and many experienced operating employees being transferred from the Bureau's helium producing facilities at Amarillo, Texas. Additional employees will be recruited from the Exell (Texas) plant and from the vicinity of the Otis plant where possible. Helium research activities of the Bureau will continue to be centered at Amarillo, Dr. Boyd said.



Alkylation installation No. 3 of the Royal Dutch-Shell refinery at Curacao (Netherlands Antilles). The Royal Dutch Company recently translated into English its "Diamond Jubilee Book," which was written last year to highlight celebration of the company's 60th anniversary.

ASTM Publishes Hydrocarbon Compilation

The American Society for Testing Materials has published an extensive compilation of tables, which includes most of the physical constants of hydrocarbons (boiling below 350 F) valuable to testing engineers and others concerned with the natural gasoline, synthetic rubber, industrial aromatics, and gaseous fuels industries. The work was directed and much of it carried out by Robert Matteson, California Research Corporation, working with Technical Committee H on Light Hydrocarbons of ASTM.

Six classes of hydrocarbons are covered in the tables, including paraffins, mono-olefins, di-olefins, acetylenes and naphthenes, and aromatics. Only those compounds having good freezing-point data were included in the compounds tabulated, on the assumption that others had not been prepared in sufficient purity.

Specifically, the tables include: Name of compound, formula, molecular weight, boiling point, vapor pressure, freezing point, the three critical constants, liquid densities (in four systems of units), gas density (in three forms), specific heats (at constant pressure and constant volume), ratios of specific heats and liquid specific heats, gross and net calorific values, heats of vaporization, refractive index at two temperatures, air required for combustion, inflammability limits, aniline point, and octane number by two methods. The data on 225 compounds are included.

The 16-page group of tables on Physical Constants of Hydrocarbons Boiling Below 350 F. (STP No. 109) is available in heavy paper cover from the American Society for Testing Materials, 1916 Race Street, Philadelphia 3, Pennsylvania, at $1 per copy.

Gas Synthesis Process Developed by B of M

Development of one of the first laboratory processes for the continuous production of synthesis gas from pulverized coal is described in a Bureau of Mines report released by the United States Department of the Interior. The process offers an easily controlled method for testing the gas making qualities of various types of fuels. Synthesis gas—a mixture of carbon monoxide and hydrogen — required for the manufacture of synthetic liquid fuels is a product of coal gasification, which is the first basic step for the indirect Fischer-Tropsch process for producing such fuels.

A free copy of Report of Investigations 4742, "Laboratory-Scale Work on Synthesis-Gas Production," may be obtained from the Bureau of Mines, Publications Distribution Section, 4800 Forbes Street, Pittsburgh 13, Pennsylvania.

Gulf Gasoline Output Up

Two new Gulf Oil Corporation natural gasoline plants at Waddell, Texas, and Eunice, New Mexico, produced 25,075,000 gal of gasoline in 1950, the first public report issued by the company on these operations reveals.

The multi-million dollar installations, which began functioning in the fall of 1949, also had a joint production of 25,310,000 gal of propane, 11,015,000 gal of butane, and 16,740,000,000 cu ft of residue gas during the year.

Blaw-Knox Office Moved

To handle the increased volume of business in the southwest, Chemical Plants Division of the Blaw-Knox Construction Company has moved its Tulsa office into larger quarters. The new office, situated at 540 East Fifth, has sufficient space and facilities to provide for 45 to 50 engineers and draftsmen that are necessary to handle the increasing number of engineering and construction contracts.

The Tulsa engineering group handles the engineering, procurement, and construction of complete plants and unit systems for the natural gas, petroleum, and chemical industries. The key personnel includes R. H. Hazlett, manager of the oil and gas department (Pittsburgh and Tulsa); Carl E. Baird, manager of the Tulsa office; Charles B. Barry, chief engineer; Kenneth W. Anderson, petroleum engineer; John R. Shaw and Dennis L. Gilbertson, project engineers; Emmett W. Fisher, senior process engineer; and Thomas G. Clark, chief draftsman.

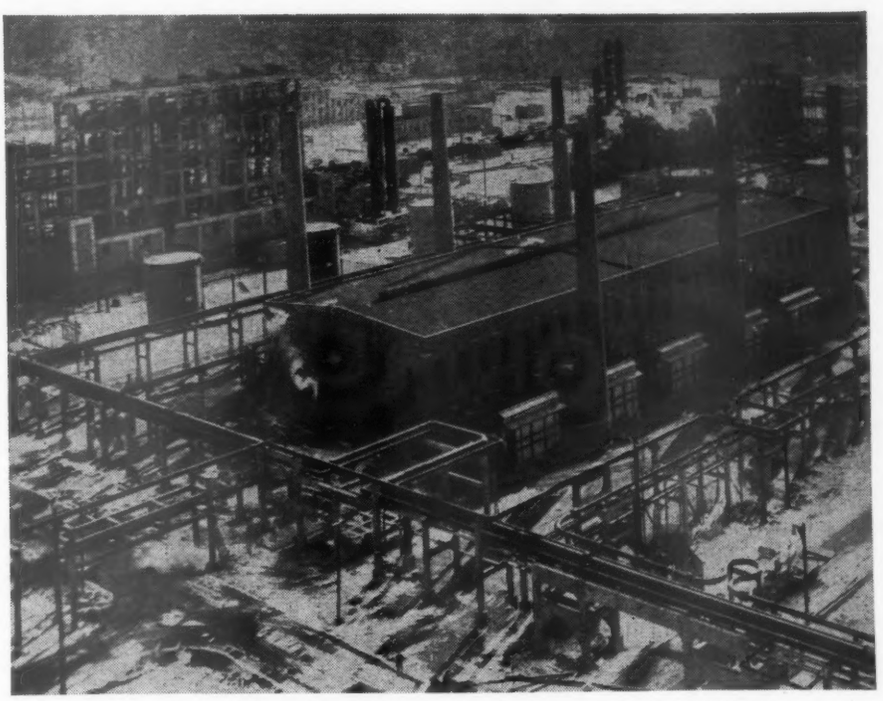
Pan-Am Expansion Program To Be Completed Next Year

Pan-Am Southern Corporation has awarded a contract to the Lummus Company to expand facilities at its Destrehan, Louisiana, refinery in connection with $6,500,000 expansion program there to produce aviation gas and jet fuel. (See story April, The Petroleum Engineer, Page C-83.)

The present refinery consists of a crude unit which processes 8000 bbl daily asphaltic crude. It has lube oil and grease blending facilities and terminalling facilities and large river dock beside 3,000,000 bbl tankage. Added capacity will produce about 7500 bbl per stream day of grade 100/130 aviation gasoline or 4000 bbl per stream day of grade 115/145 plus 200 bbl per stream day grade 111/130. Jet fuel production will be 5000 bbl per stream day.

The revamped crude unit will permit simultaneous processing of 15,000 bbl per stream day of light coastal crude to a low percentage of fuel oil bottoms and 5000 bbl per stream day crude to asphalt bottoms. Catalytic cracking unit will process 12,000 bbl per stream day gas oil at high conversion and will operate in blocked operation with a retreating cycle.

The vapor recovery unit will recover light ends from fluid catalytic cracking unit. Products from the vapor recovery unit will consist of PP-BB charge recovery unit designed so that recovery of propylene can be varied from 60 volume per cent to practically zero volume per cent. Alkylation unit will use sulfuric acid as catalyst. Capacity of unit will be 2500 bbl per stream day of aviation alkylate. Flexibility will be installed to allow for alkylation of mixed propylene butylene or butylenes alone. Construction units will begin immediately, and they are expected to be completed by July 1952.



Styrene cracking unit at Koppers' polystyrene plant in Kobuta.

Koppers to Expand Facilities

Koppers Company, Inc., has announced a multi-million dollar program of expansion for its chemical division, which provides for construction of a new plant near Port Arthur, Texas, and additions to its present facilities at Kobuta, Pennsylvania. Dan M. Rugg, vice president and general manager of the chemical division revealed that the program will, within a year, make it possible to increase the Division's production of styrene monomer by about 33 per cent, and to increase the division's production of the popular plastic, polystyrene, by about 25 per cent.

Koppers has contracted to purchase about 1000 acres of land, located about 2 miles west of Port Arthur, Texas, Rugg said. On a portion of this land, Koppers will construct a plant that will take ethylene from the unit that Gulf Oil recently announced it will build at its Port Arthur refinery and combine it with benzene to make ethyl-benzene.

New facilities at Kobuta will include those to increase the production of styrene monomer, which is essential to the synthetic rubber program. Some increase also will be made in facilities to produce the plastic, polystyrene, from styrene.

Miniature Ion-Exchange Unit

An interesting new development in Ion-Exchange is the Filtr-Ion, a pint-size refillable water purification unit on the Monobed ion exchange principle, announced recently by La Motte Chemical Products Co., Towson, Baltimore 4, Maryland. This unit is designed primarily for laboratories, hospitals, garages, photographic units, for soil analysis, and other applications where small amounts of pure, ion-free water are needed, but where larger, more expensive units are impractical.

The tube is 8½-in. long by 1⅝ in. diameter, is filled with a special unit that removes both cations and anions from ordinary faucet water, yielding water essentially deionized, as much as 10 gal of pure water being obtained from each refill, water of laboratory quality. A Fiberglas filter removes solid impurities from the water at the same time. The unit does not remove bacteria or un-ionized materials. The medium is composed of Amberlites, developed by the Resinous Products Division of Rohm and Haans Company of Philadelphia. The resins change from blue-black when fresh to light yellow, in a gradually descending line when exhausted. Each refill package holds enough for two complete refills, including filter elements.

Process Heating Seminar

May 26th has been set as the date for the second annual John Zink Process Heating Seminar at the John Zink Company plant, 4401 South Peoria, Tulsa, Oklahoma. Plans for attendance by more than 300 engineers from process industries of the U.S., Canada, and Mexico are being made.

Gasoline-From-Coal in South Africa

The first commercial Synthol process plant has been announced by M. W. Kellogg Company, to be built for South African Coal, Oil and Gas Corporation, Ltd., (SASOL). It is to be constructed on the Vaal River, 40 miles south of Johannesburg, near Coalbrook, Orange Free State, and work has already begun on the plans and designs of the installation.

The Synthol process is the American development by Kellogg, and Cities Service interests of the so-called Fischer-Tropsch process for converting coal and other organic materials into petroleum-like hydrocarbons, and oxygenated organic chemicals. In South Africa the plant will include coal mines to supply the raw material from which the hydrocarbon and other products are made. A gasification plant, to produce the synthesis gas from coal, a mixture of carbon monoxide and hydrogen will be built, reportedly based on German developments in this field.

This synthesis gas will be charged to the Synthol unit, developed by Kellogg and their collaborators in a large pilot plant in Jersey City. A new reactor has been developed, employing the fluid catalyst principle, a method that solves one of the major problems the Germans never did work out satisfactorily. This solution, it is believed, has made the process practical when economic conditions promise a fairly adequate product price structure. The removal of the great amount of heat generated during the process is made feasible for the first time by this development of the fluid reactor. New catalysts, among them one composed largely of iron, have given the synthesis a new lease on life.

The unit will be directed primarily toward production of liquid fuels of the gasoline and diesel fuel types. Little if any petroleum reserves are found in South Africa but large deposits of low-cost coal are available. The present price structure for petroleum products will enable the local installation to operate profitably and may eventually make South Africa independent of outside liquid fuel supplies, it is believed. Several gas generators will be installed, any one of which will supply a city of 150,000 inhabitants with fuel gas. The plant is to be immediately adjacent to the coal deposit, which will be tapped, and the entire project begins from the ground up by sinking shafts, building employee quarters in a good-sized city. Large oxygen concentration units will be built, complete chemical processing equipment amounting to a large refinery. Provision will be made for concentrating the chemicals formed, for disposal as solvents or for any other purpose, which may include dehydration and reconversion to hydrocarbons.

The Kellogg Company will serve as project manager of the entire construction job and its foreign subsidiary, Kellogg International Corporation, will supervise construction and procurement of materials required.

Israeli Refinery Planned

Consolidated Refineries is planning installation of a new petroleum cracking plant at Haifa, Israel, which is expected to be in operation in the summer. The new plant will produce the best quality gasoline heretofore available in Irael, and also, for the first time, high octane aviation fuel and gases for the nitrogen plant that the Israeli government plans to build. The new unit will bring operations of the Haifa plant up to 25 per cent of capacity, an increase of 40 per cent over last year's output.

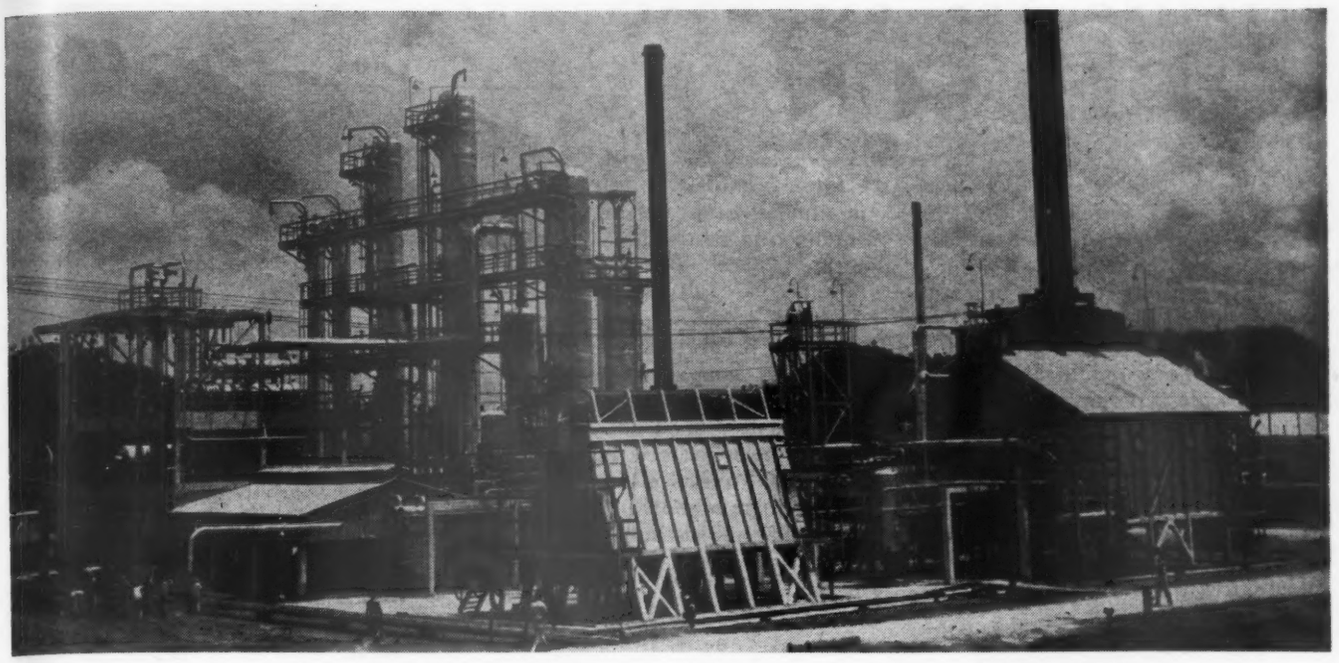
Sarnia Refinery Expanded

Engineering of several major processing units for Canadian Oil's new $18,000,000 refinery at Sarnia, Ontario, has progressed from the planning stage to the production phase and construction will start some time in April, according to The Canadian Kellogg Company, Ltd., refinery and chemical engineer-contractors of Toronto. Canadian Oil Companies and Canadian Oil Refineries will own and operate the refinery.

Completion of the plant, for which Canadian Kellogg will design and erect combination Fluid catalytic cracking and catalytic polymerization unit as well as special fractionating equipment to produce butane and propane, is scheduled for 1952. The combination unit, first of its kind to have the new Orthoflow catalytic cracker operating in combination with cat poly, will produce high-octane stock for both aviation and automotive gasoline. Gas oil feed for the cracker will be produced from 20,000 bbl per day of Alberta crude.

LPG Hits New High

The 1950 demand for liquefied petroleum gas rose to a new record in 1950, according to statistics from the Bureau of Mines. Estimated demand for the year totaled 3,000,019,000 gal, a gain of 21.6 per cent from the 1949 total of 2,467,156,000.



Refinaria Nacional de Petrolea, S. A., has put on stream this refinery at Bahia, Brazil. The first of its kind in Brazil, it has a capacity of 2500 bbl a day.

First Cracking Refinery Placed on Stream in Brazil

The first refinery to produce cracked gasoline in Brazil has just recently been placed on stream at Bahia for Refinaria Nacional de Petroleo, S.A. by The M. W. Kellogg Company, refinery and chemical engineers of New York City.

A complete combination crude distillation and thermal cracking plant, the refinery is capable of processing 2500 bbl of crude each day. It is the first of its kind to be built in Brazil and, according to Kellogg, represents the most modern type of thermal combination processing.

Operating off one control room, the refinery employs a minimum of intermediate storage tanks and processing vessels. It combines low investment cost and reduced operating expense with the production of high quality thermally cracked gasoline and other petroleum products, states Kellogg.

AIChE Meet in Missouri

Ammonia synthesis, innovations in petroleum refining, reaction kinetics, and influence of finances on engineering expansion are among the important topics being discussed at the Midwest regional meeting of the American Institute of Chemical Engineers, Hotel President, Kansas City, Missouri, May 13-16. A series of inspection trips to an oil refinery, a soap plant, a steel works, a corn processing plant, The Midwest Research Institute, Spencer Chemical Company, and other companies is planned for students and those wishing to participate.

Colorado Oil Shale Estimates Raised

Recent sampling of the Green River oil-shale formation in northwestern Colorado, where the Bureau of Mines is mining shale and producing shale oil on a demonstration scale, has increased previous estimates of shale deposits in this area substantially, Secretary of the Interior Oscar L. Chapman has disclosed.

On the basis of sampling and assay data obtained since 1944, a Bureau of Mines report released by Secretary Chapman says, partly blocked out and geologically inferred shale running 25 gal a ton or more in the richest area theoretically would yield 125 billion barrels of oil, the actual recovery depending on mining and processing losses. Combined with deposits of 15-gal-a-ton shale, the theoretical yield in the entire area rises to 494 billion barrels.

The Green River formation in northwestern Colorado covers about 2590 square miles and the Piceance Creek basin between the Colorado and White Rivers, where all the sampling was done, covers about 1650 square miles, Carl Belser, Bureau mining engineer who prepared the report, stated. About 1000 square miles in the basin is believed to contain shale of possible economic importance.

A free copy of Report of Investigations 4769, "Green River Oil-Shale Reserves of Northwestern Colorado," can be obtained from the Bureau of Mines, Publication Distribution Section, 4800 Forbes Street, Pittsburgh, Pennsylvania.

Germany to Build Houdriflow Unit

Gewerkschaft Erdol-Raffinerie Emsland, a German petroleum company, will install a Houdriflow catalytic cracking unit at its new refinery in Linger, Germany, a short distance from the Dutch border, it was announced by D. N. Hauseman, president of Houdry Process Corporation.

A Houdry fixed-bed unit, situated in Berre, France, has been operating for several years and is the only catalytic cracking unit in operation in Europe. The Lingen installation, which will be situated in the new Emsland oil field, will be the first of the modern Houdriflow moving-bed units to be built in Europe.

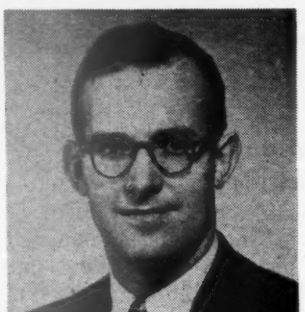
The Houdriflow process, which was introduced in 1948, was the first to make use of the gas-lift principle for transporting the pelleted or spherical type catalyst used in moving-bed units.

Canadian Petrochemical Company Being Formed

The British American Oil Company Limited and Shawinigan Chemicals Ltd. will soon form a jointly owned petrochemical company. Engineering studies of a number of projects are well advanced. Plant construction will begin within a few months using a newly developed process, which promises substantial economies in the production of certain basic chemicals now in great demand. The raw materials will be produced in Canada, and the chemical products will be utilized by Canadian factories.

—PERSONALS—

George E. Shaw, of Petro-Chemical Equipment Company, Inc., of Houston, Texas, is on a mission of several weeks duration in Iran in a consulting capacity in connection with filtration problems at the Abadan refinery of Anglo-Iranian Oil Company. Shaw is well known in filtration circles due to a wide experience gained both before and since the organization of Petro-Chemical Equipment Company, a corporation specializing in filtration engineering, materials handling, electric motors and power transmission equipment and allied lines in association with J. C. Riley, Jr., and H. C. Scott.



Gordon Kiddoo

Gordon Kiddoo was appointed assistant director of National Research Corporation's petrochemical research department. Kiddoo received his degree in chemical engineering from Cornell University in 1942. Subsequently he was employed by the Chicago Corporation, Corpus Christi, Texas, in oil and gas production and cycling plant operations near Bishop, Texas. Kiddoo will be in charge of the engineering economics aspects of the petrochemical research program which National Research Corporation is undertaking jointly with Electric Bond and Share Company and United Gas Corporation.

T. Nicholas Bath has accepted the position of chief lubrication engineer for the Battenfeld Grease and Oil Corporation. Bath was graduated from the University of Illinois in 1929 with a degree in chemical engineering. He served as a chemist for the Pennsylvania Petroleum Company and the Kansas City Testing Laboratories before joining the Shell Oil Company in 1935. When he left Shell Oil in 1950, he was assistant manager of the lubrication department.

Dr. Manson Benedict, whose appointment as professor of chemical engineering at the Massachusetts Institute of Technology was announced recently, will also serve as scientific director of the National Research Corporation, Richard S. Morse, its president, has announced. Dr. Benedict received his bachelor's degree in chemistry from Cornell in 1928. Subsequently he was a research chemist at National Aniline & Chemical Company. He renewed his studies at the Massachusetts Institute of Technology where he received his masters degree in 1932 and his doctorate in physical chemistry in 1935. As scientific director of National Research Corporation, Dr. Benedict will initially place particular emphasis on the new petrochemical research program, which is being undertaken jointly with Electric Bond and Share Company and the United Gas Corporation.

Arthur H. Sherwood, Eastern district sales manager for Petro-Chem Development Company, passed away at his home in Garden City, Long Island, at the age of 70 years. "Sherry," as he was known throughout eastern refining circles, was a pioneer among oil equipment men. A graduate of Cornell University in 1901, all of his business years were identified with oil refining equipment; Wilson-Snyder Pump Corporation, U. S. Steel Corporation, and lately with Petro-Chem Development.

Philip C. McGrath

Philip C. McGrath, formerly chief process-engineer for C. F. Braun and Company of Alhambra, California, now heads the project-engineering department. McGrath, who has been with the engineering company for 22 years, is a graduate of the Massachusetts Institute of Technology. He is a member of the American Chemical Society and the American Society of Mechanical Engineers.

Irving J. Staid

Irving J. Staid, Billings, Montana, has been appointed manager of The Carter Oil Company's manufacturing department. Staid, a native of Peabody, Massachusetts, graduated from the University of Alabama in 1938 with a degree in chemical and metallurgical engineering and immediately began work as a chemist in laboratories of the Esso Standard Oil Company refinery at Everett, Massachusetts. After extensive experience with Esso Standard, Staid joined Carter in 1945 as chief engineer of the Billings refinery.

It was also announced that **Herman G. Gunter** had been appointed assistant manager of the manufacturing department. Gunter graduated in engineering from Johns Hopkins University and joined the Jersey Standard organization in 1930 as an analyst in the chemistry laboratory of the Baltimore refinery. After service in several of the Jersey refineries, he joined Carter in 1947 and has been general superintendent in charge of operations at the new Billings plant.

Lyle R. Duty has been named assistant to the executive vice president and **Carl M. Peters** has been appointed manager of economics, Pan-Am Southern Corporation. Duty was with Standard Oil Company (Indiana) for 22 years before joining Pan-Am Southern. Peters was formerly employed in the research department of Standard Indiana. He was graduated from the University of Virginia in 1941 and from Princeton University in 1942 with a master's degree in chemical engineering.

William H. Bowman, Max Neuhaus, and **L. P. Scoville** have been elected vice presidents of Jefferson Chemical Company, Inc. Jefferson was formed in 1944 by The Texas Company and American Cyanamid Company to manufacture chemicals from petroleum hydrocarbons. Neuhaus and Scoville have been on Jefferson's staff since the company was organized. Neuhaus, who went to Jefferson as manager of its technical and re-

search department, had previously been with The Texas Company and Texaco Development Corporation since 1932. Scoville went to Jefferson in 1944 as chief engineer, and was subsequently promoted to manager of the production department. Prior to his service with Jefferson, he was senior engineer for The Texas Company, where he served for 12 years. Bowman became Jefferson's market development manager in 1945, and when the company's sales department was organized, he was named manager of that department.

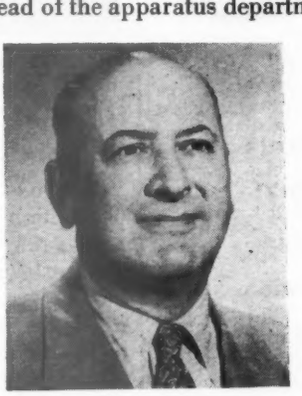
C. S. Davis has been appointed plant manager of America Cyanamid Company's new petroleum cracking catalyst plant at Michigan City, Indiana. The new plant is scheduled to go into operation in June, 1951. For the last two years, Davis has been general superintendent of the company's plant in Marietta, Ohio, where dyestuffs and intermediates for pharmaceuticals are manufactured. He is a graduate of the Newark College of Engineering with the degree of chemical engineer. After his graduation in 1926, he worked for approximately six years on synthetic aromatic chemicals and nitrocellulose solutions. In 1932, he joined the Chemical Construction Corporation, a Cyanamid unit.

C. S. Davis

William R. Seuren, formerly assistant to W. J. Carthaus, vice president in charge of Deep Rock Oil Corporation's manufacturing and research division, has been named supervisor of lubricating oil finishing at the company's Cushing, Oklahoma, refinery. **Donald T. Axon** will fill the position vacated by Seuren's promotion. A native of New Jersey, Seuren came to Deep Rock in 1949 after receiving his master's degree in business administration from Harvard University. He obtained his B. S. degree in chemical engineering from Pennsylvania State College and his M.S. in chemical engineering from Massachusetts Institute of Technology. Before going to Harvard in 1947, Seuren worked as process engineer with Foster Wheeler Corporation, E. B. Badger and Sons, and Stanolind Oil and Gas Company.

Fred L. Story has been appointed head of the process-engineering department for C. F. Braun and Company of Alhambra, California. Story has been with the enineering company for 16 years. During that time he has held several responsible posts, serving successively as senior process-engineer, assistant process-engineer, and head of the apparatus department.

Fred L. Story



Osher Goldsmith

Osher Goldsmith has been appointed director of the fuels and chemicals division in the regional Office of Price Stabilization.Goldsmith has been serving as a consultant in the OPS office in Dallas, Texas, since it opened January 29. For an interim period during organization of that office, Goldsmith served as acting regional price executive, in charge of administering the price program for all commodities affected.

R. L. Tollett, president of Cosden Petroleum Corporation, Big Spring, Texas, was elected president of the Western Petroleum Refiners Association for the year 1951-52.

Elected vice presidents were: **H. J. Kennedy,** Continental Oil; **F. L. Martin,** Sunray Oil; **Roland V. Rodman,** Anderson-Prichard Oil, and **J. W. Vaiden,** Skelly Oil.

John C. Day was named secretary treasurer; **Virginia W. Campbell,** assistant treasurer, and **Fayette B. Dow,** general counsel.

Elected to the board of directors were: R. L. Tollett; R. G. Bandy, Midland Cooperative Wholesale (Cushing refining division); Paul G. Blazer, Ashland Oil and Refining; Reid Brazell, Leonard Refineries, Inc.; Rex S. Blazer, Allied Oil; W. J. Carthaus, Deep Rock Oil; Sheldon Clark, Sinclair Refining; O. L. Cordell, Bareco Oil; F. H. Dunn, Wilcox Oil; Lee Haugen, Cities Service; I. A. Helling, El Dorado Refining; A. M. Hughes, Phillips Petroleum; R. R. Irwin, Socony-Vacuum Oil, (White Eagle); H. J. Kennedy; J. P. Langfitt, Pure Oil; R. E. Luton, Ohio Oil; L. D. Mann, Cities Service Refining; F. L. Martin, Sunray Oil Corporation; T. M. Martin, Lion Oil; Brown L. Meece, Globe Oil and Refining; M. H. Robineau, Frontier Refining; Roland V. Rodman; J. W. Vaiden; J. W. Warner, Tide Water Associated; J. S. Wertz, Vickers Petroleum.

Tanker Pool Speeds Fuel To Armed Forces

A newly formed voluntary pool of tankers from the oil industry fleet is helping speed vital cargoes of aviation fuel, gasoline, engine oil, and other petroleum products to America's armed forces.

Known as the "Volunteer Tanker Allocation Pool," the group was organized to assure sufficient carrying capacity to meet extensive petroleum needs of the nation's mobile and mechanized defense forces.

In a period that sees America's life line stretched practically around the world, tankers have the important job of supplying the life blood to that line. They carry oil to fighting men in Korea, to the ships at sea, to far away spots where other Americans are ready to fight if necessary, and to U. S. allies throughout the world.

Canada Gets First Platforming Unit

Canadian Oil Company will install Canada's first platforming unit at its Froomfield, Ontario refinery. The new unit will have a capacity of 3800 bbl per day; the entire refinery's throughput will be 20,000 bbl. Universal Oil Products Company will design and build the unit.

Take Time to Save Time— And Money

Many items of equipment that will save you hours of time and your company thousands of dollars are described in the ads in this issue and in the New Machinery Department beginning on page E-49.

Use the reply card, requiring no postage, to obtain complete details and prices.

Something new

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The creation of a separate CHEMICAL-PETROLEUM DIVISION for these two vastly important industries is our recognition of the great progress taking place in the Chemical-Petroleum Field and of the continuous increase in volume of business to National Airoil Burner Company from that Field.

For almost 40 years National Airoil Burner Company has, step by step, kept pace with developments in the Chemical-Petroleum Industries. Now, we take added confidence and pride in knowing that we will be even better able to serve these industries.

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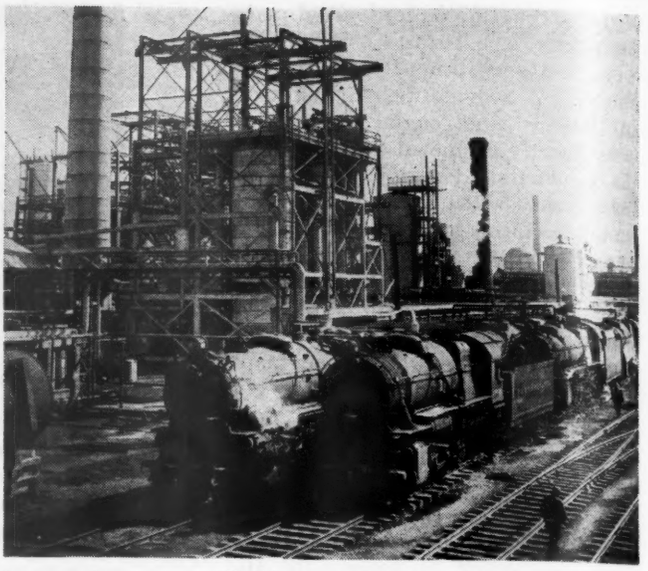


Locomotives were called into service as mobile boiler houses at Sun Oil's Marcus Hook refinery.

Railroads Provide Steam for Refineries

Railroad locomotives are playing a unique role in the production of military aviation gasoline at Sun Oil Company's refinery in Marcus Hook, Pennsylvania. Pressed into service because of a serious delay in the delivery of large new boiler equipment, a dozen engines on railroad sidings inside the refinery are helping to provide the steam requirements of the aviation gasoline plants.

Use of the locomotives as "mobile boiler houses" has permitted Sun to meet in full its aviation fuel commitments to the Armed Forces. Sun is making large quantities of this fuel for the military. Steam from the locomotives passes through manifolds to lines connected with the refinery's main steam system, supplementing the supply from existing sources. The operation continues day and night.

Uranium Refinery Will Be Constructed

The United States Atomic Energy Commission will construct a uranium ore refinery and other facilities for the production of uranium feed materials on a 1200 acre site near the Miami River, 19 miles northwest of downtown Cincinnati, Ohio. The new installation will produce uranium in forms suitable for use in the AEC's fissionable materials production plants.

The new facilities are being designed by Catalytic Construction Company of Philadelphia. In announcing the new site, Wilbur E. Kelley, manager of the New York operations office stated that no atomic weapons would be made at the site and that operations there would create no environmental toxic or radiological hazards.

Drums Cleaned By Machines

Two Rotoblast drum cleaning machines, Models ES-400 and ES-382, which simplify and speed-up the removal of dirt, rust, paint and other foreign materials from 30 and 55 gal returnable steel drums and lids before reuse, are announced by Pangborn Corporation, Hagerstown, Maryland.

Metal abrasive, hurled against both the interior and exterior surfaces of the drum by centrifugal force, scours the meatl in seconds, leaving no chemicals or alkalies to wash off, and providing a clean bonding surface for repainting. Drums are automatically handled during the cleaning operation—only one man can load and unload the barrels.

Models ES-400 is designed to clean 1000 to 1100 drums and drum heads a day, or 125 to 140 per hour. Model ES-382 will clean 320 to 560 drums and covers per day.

Pipe Line Outlook

ARRIVAL of open weather to some parts of the country has made it possible for certain pipe line projects, which have been marking time during severe winter months, to get under way. Other projects are ready to begin as these weather conditions become general.

Allocation of pipe is still the major consideration in the future of pipe line construction. The industry has had no definite instructions from Washington regarding how it will be ranked in the matter of priorities. A heartening note is sounded, however, by W. C. Kinsolving, president of the Sun Pipe Line Company, writing in this issue of The Petroleum Engineer, who states that 1951 will see the greatest pipe line expansion in the country's history. He estimates that 19,000 to 20,000 miles of pipe lines will be laid this year compared with last year's banner attainment of 16,000 miles. He qualifies his statement by saying that government restrictions or steel shortages could "throw up unexpected roadblocks". He further says, however, that the Petroleum Administration for Defense has assured that everything in its power will be done to aid the industry in expanding to meet military and civilian requirements. The steel industry's expansion to increase production also will be a mighty factor in making it possible to carry out the program.

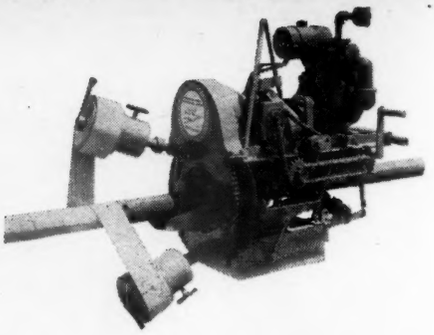
Other important forces also are lending their influence to bring about accelerated transportation construction. Paul Kayser, president of El Paso Natural Gas Company, and president of the Independent Natural Gas Association of America, speaking before the American Petroleum Institute at Amarillo, Texas, strongly urged that the natural gas industry be allowed to expand during the national emergency. To those pessimistic enough to believe that the industry might over expand, he pointed out that, if the time ever comes when natural gas supplies are exhausted, the pipe lines will not be wasted but can be used to transport and distribute synthetic fuels.—F.H.L.

Pipe Line Archaeology

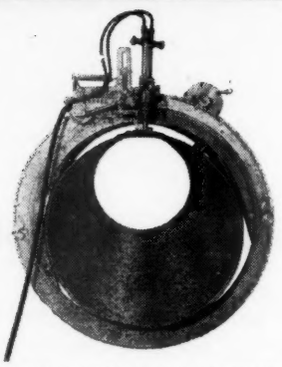
PIPELINING is really putting on class. Who would have thought a few years back that pipelining and archaeology would have anything in common. Such is the case, however, and an article in this issue tells some extremely interesting facts in connection with the construction of El Paso Natural Gas Company's San Juan Project.

The pipe line route is through the center of the American Indian Pueblo civilization. Many of the dwellings of these ancient people have been buried for centuries and are being uncovered as pipe line ditch is made. Since these ruins and other items of historical interest cannot be disturbed except by permission and under proper procedure, six archaeologists were placed on the El Paso payroll. Their efforts have resulted in the preservation of much worthwhile material, which is being studied, then placed with museums.—F.H.L.

First Choice...



The 2"-4" Crose line-traveling coating and wrapping machine illustrated is light weight and compactly designed. These features are extremely essential for proper coating of small diameter pipe. Equipped with the patented Crose coating spray ring.



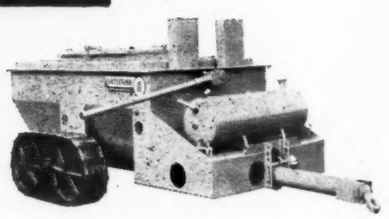
CROSE PIPE CUTTING AND BEVELING MACHINES—Ideal for fast, true cutting and beveling of pipe. Available in six sizes for 4" to 36" pipe. Machines for 16" pipe and above have "Out-of-Round" Attachment as standard equipment. Made of strong aluminum alloy.

M.J. CROSE

30 BARREL CAPACITY

23 BARREL CAPACITY

CROSE-LITTLEFORD PIPE COATING KETTLES are equipped with hydraulically controlled agitator, low pressure burner, dial-type thermometer and a Wisconsin air-cooled gasoline engine with electric starter. If the agitator becomes fouled, the hydraulic fluid by-passes until the agitator is freed. The low pressure burner uses any type of low-grade fuel oil and distributes heat equally over all parts of the bottom. This burner is designed to avoid hot spots thereby eliminating the necessity of replacing bottoms. These completely insulated kettles may be purchased on Athey tracks or on skids for stationary coating yards. Over 150 of these kettles are in service in the United States and Canada.

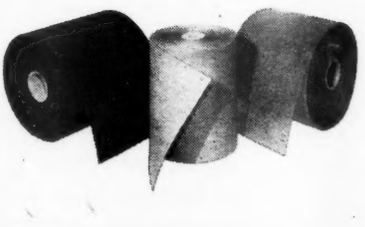


10 BARREL CAPACITY

CROSE-LITTLEFORD PIPE COATING KETTLES are equipped with manually operated agitator, two No. 5 burners and can be furnished mounted on Athey tracks or skids. This kettle also available with hydraulically controlled agitator and Wisconsin air-cooled engine. This kettle has been proven in field service.

CROSE COATING STRAINERS fit all makes of pipeline coating kettles—has easily removable wire mesh filter element.

CROSE PIPE CRADLES handle pipe sizes from 4" to 34" in diameter. Cradle illustrated can be adjusted to cradle pipe from 16" to 26" in diameter.



PIPE WRAPPING MATERIALS — VITRON Glass Fiber Underground Pipe Wrap has been proven on thousands of miles of pipeline. VITRON Glass Fiber Underground Pipe Wrap, Asbestos Felt and Kraft Paper are all available for immediate shipment from warehouse stocks at Tulsa, Okla. or Houston, Tex.

Pipe Line Industry's Greatest Year

Construction in 1951 expected to total 19,000 to 20,000 miles, breaking all previous records — PAD assures its support

WILLIAM C. KINSOLVING

THE year 1951 will see the greatest pipe line expansion in the country's history, barring unforeseen contingencies.

Statistics recently compiled show that pipe line construction will be pushed ahead by 19,000 to 20,000 miles this year with plans already in the making for additional thousands of miles of pipe line.

Actually, plans—notably in the gas utility industry—do not stop even there but are being formulated for expansion over the next five years.

Last year, of course, was a banner year in itself with more than 16,000 miles of pipe laid. Natural gas led the way with considerably better than 10,500 miles of line, crude was next with 3200 miles, and there were 2500 miles also laid for products.

This year, however, all previous records are expected to be shattered unless governmental restrictions or steel shortages throw up unexpected roadblocks.

In this connection, we are assured by Petroleum Administration for Defense that it will do everything in its power to help the industry meet its expansion for both military and necessary civilian requirements.

The steel industry, too, is meeting 1951's problems head-on, which is vitally important to pipelining because tubular goods of all kinds are in short supply.

A record $1,200,000,000 will be spent this year by iron and steel companies for expansion and improvement. American Iron and Steel Institute has said that 35 to 40 companies are engaged in increasing their iron and steelmaking capacities. It is predicted further that steelmaking furnaces by the end of 1952 will be able to make more than 117,500,000 tons annually at full production compared with 104,230,000 tons a year at present.

Of this total, it is expected that sufficient steel will be allocated for the pipe lines now being laid down and those being planned to continue the rapidly spreading network over the United States from the production fields of the Southwest.

Given the cooperation of suppliers and the government, the pipe line industry will meet its national defense requirements and the pipe will go into the ground.

In this connection, the recent report of the Committee on Petroleum Transportation of the National Petroleum Council bears sharply on the job that will be done.

The committee stated in plain language that existing and planned facilities are sufficient to do the jobs now in sight.

The report also had this to say in regard to new construction:

"In making such a statement as to adequacy, the importance of completing the construction of certain planned facilities must be particularly emphasized.

"The completion of such facilities is conditioned upon the availability of steel and other materials in short supply in proper cases favorable government action permitting accelerated amortization of privately financed projects, and many other contingent factors."

The report also pointed out that the nation is fortunate at this time to have, as a result of competition and other economic factors, the transportation facilities of the various types required for oil and gas movements, which have been developed and integrated into a highly efficient system.

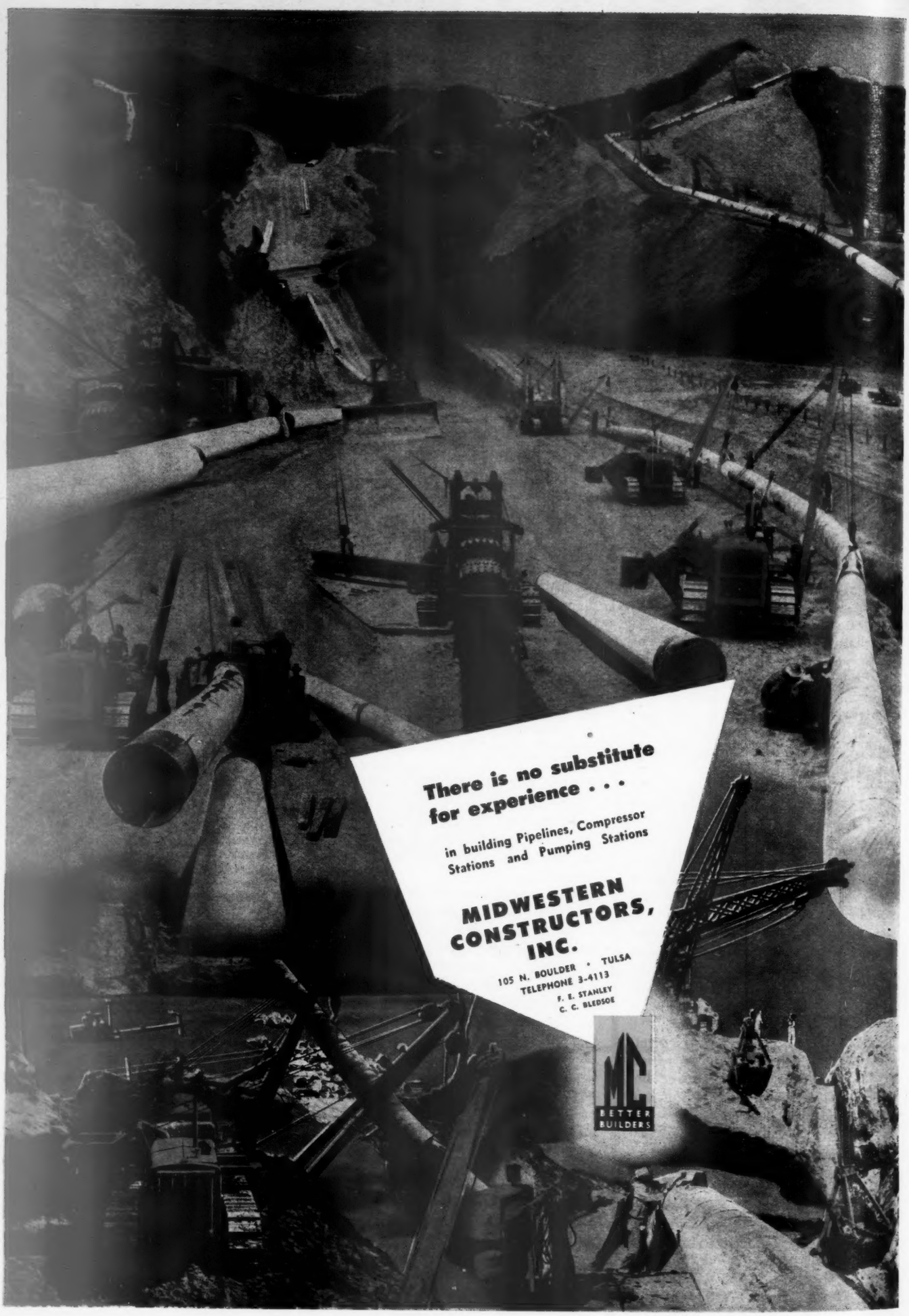
This being the case, the consuming public—which is the Nation—may rest assured that the pipe line section of the petroleum industry is not resting on previously won laurels.

It is working day and night and, if called upon, will be ready for sudden drafting of its facilities to meet full military requirements. * * *

The Author

W. C. Kinsolving is president of the Sun Pipe Line Company (Texas), Susquehanna Pipe Line Company, and chairman of the board of the Mid-Valley Pipeline Company. He joined the staff of Sun Oil Company immediately upon receiving a degree in electrical engineering from Cornell University. This was in 1923 and he was an ordinary oil-field hand. Advancing through various stages of oil-field work, eventually he was placed in charge of construction of a products pipe line in the East (1930-31). He then went to Texas to direct the construction and operation of a crude oil line from the newly discovered East Texas field to the Gulf Coast. In 1942 he was called to Washington to serve as assistant director of transportation for the Petroleum Administration for War. In this capacity he figured prominently in the planning and construction of the "Big Inch" and "Little Big Inch" pipe lines. Later he was commissioned a colonel in the Army Corps of Engineers and played a prominent role in the building of the China-Burma-India pipe line. Upon completion of this war service he returned to Sun as manager of all pipe line operations, later becoming president.

EXCLUSIVE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Lowering-in a drag section on the main line of the San Juan Project of El Paso Natural Gas Company. This particular section was extra-thick pipe to lessen the possibility of flood damage to the pipe line. It was 2521 ft long, required 7 side-boom cats for lowering in.

P 623.

El Paso Now a Two-System Company

Completion of San Juan Project will give El Paso Natural Gas Company its second pipe line system — During last 12 months, 1200 miles of pipe were laid on this and its "Southern Lines."

B. MARSHALL WILLIS

STATISTICS on El Paso Natural Gas Company became obsolete in a hurry in the 12 months from March 1, 1950, through April 30, 1951. Construction crews laid down more than 1200 miles of pipe—most of it big inch—to set a new record for the company. Daily gas deliveries, for the first time, climbed to more than 1,000,000,000 cu ft. Population served by the company jumped to 12,000,000 people when, in August, service was instituted to northern California including San Francisco and the other bay area cities. Last, but not least, the company became an organization with two pipe line systems when, in July, it was authorized to construct an entirely new pipe line several hundred miles north of its present lines.

All but a minor portion of a five-year, $200,000,000 expansion program on El Paso Natural Gas Company's lines from the Permian Basin westward through west Texas, southern New Mexico, and southern Arizona was completed during the year. Certain expansion proposals on the southern lines are pending with the Federal Power Commission but, as of right now, authorized construction on the Permian Basin lines of the company is, for all practical purposes, complete.

A major part of the construction on the northern pipe line system was accomplished during the year by El

EXCLUSIVE

Paso Natural Gas Company. Known as the San Juan project, this pipe line system originates in the San Juan Basin of northwestern New Mexico and southwestern Colorado and extending in a southwesterly direction across northern Arizona, connects with the southern lines of the company at a point near Topock, Arizona.

The San Juan pipe line will not only increase and "firm up" deliveries of natural gas to Pacific Gas and Electric Company, which, in turn, carries the gas to northern California, but it will make it possible for natural gas service to be instituted throughout communities in northern Arizona and northwestern New Mexico and the extensive Navajo Indian Reservation. Deliveries through the line to PG and E will average 150,000,000 cu ft a day; deliveries to communities along the line will amount to 17,000,000 cu ft a day to bring the company's total authorized deliveries to 1,063,000,000 cu ft a day.

Representing a $44,500,000 investment, the San Juan project will perform an outstanding service. El Paso Natural Gas Company's growth during the last several years has been accomplished almost entirely through increasing utilization of residue gas. Residue gas is a by-product of the production of oil and natural gasoline. For many years, the Permian Basin in west central Texas and southeastern New Mexico was dotted with huge flares as this gas was burned because there was no satisfactory market for it.

In a nation with an oil economy, these flares apparently had to be. Production of oil was essential, but when oil was brought out of the ground, residue gas was also forthcoming. Carbon black companies used some of this gas in their operations, and El Paso Natural Gas Company carried some to market even before the inception of its expansion program in 1946. The volume of residue gas being produced was far in excess of the market for the gas, however, and there was nothing to do but to burn it.

Since 1946, however, extensive gathering lines laid by El Paso Natural Gas Company have taken more and more of this residue gas into the company's system. In 1950, the company carried nearly 200,000,000,000 cu ft of residue gas to market and, currently, three-fourths of its deliveries are residue gas.

In its program to convert residue gas to useful purposes, El Paso Natural Gas Company has to solve one very immense problem: Because residue gas is a by-product of the production of oil, the rate at which it is produced is determined by the market demand for oil and not by the need for gas. The rate of production of residue gas is subject to tremendous fluctuations—seasonal, monthly, weekly, daily, and hourly—none of which are controllable by El Paso Natural Gas Company.

For example, when oil producers achieve their allowables as set by state regulatory agencies, these producers shut down their wells. When oil production is shut down, residue-gas production also stops. This means that supplies of residue gas are severely curtailed, if not altogether shut-off for several days at the end of a month.

Obviously, it is essential that natural gas be delivered regularly and dependably regardless of the situation concerning the production of oil. In order to market residue gas, therefore, it is necessary to have wells supplying "dry" gas that can be turned on or off as necessary to fill the gaps between demands for natural gas and available supplies of residue gas.

Predominantly, natural gas in the Permian Basin is residue gas. El Paso Natural does have in the Permian Basin a number of dry gas wells that it uses to "firm up" supplies. There is more residue gas being produced in the Permian Basin, however, than it is possible to market with the supplies of dry gas available there.

The Author

B. Marshall Willis, author of this resume of El Paso Natural Gas Company's construction program, is editor of *The Pipeliner*, the company's magazine.

He has been associated with the natural gas industry for nearly six years, five of them with El Paso Natural Gas Company and one as senior industrial engineer of a company that manufactures instruments and valves. His business background also includes 3½ years in market analysis and market development for United States Rubber Company.

He is an alumnus of Texas Western College and Harvard University's Graduate School of Business Administration. At Harvard, he held a National Scholarship. "Majored in Wellesley, minored in dishwashing," he says.

He is a member of the Independent Natural Gas Association of America, the American Marketing Association, the American Association of Industrial Editors, the Society of Associated Industrial Editors, the American Statistical Association, the Rotary Club of El Paso, the El Paso Chamber of Commerce, and the Harvard Club of New York.

The suspension bridge over the Pecos River at the right supports 16-in. pipe; the one at the left supports 26-in. pipe. The vehicular bridge at the left supports two 30-in. and one 16-in. pipelines. The vehicular bridge was completed and put into operation during 1950.

Removing stumps on the right-of-way of the 24-in. main line of the San Juan Project. Bulldozers made quick work of the huge pine stumps.

The San Juan Basin, on the other hand, is predominantly a dry gas area. The facilities that El Paso Natural Gas Company is constructing in that area will be used primarily to deliver supplies of dry gas to meet the deficiencies in the supplies of residue gas that occur in the Permian Basin from time to time. This means that the northern lines will operate at full capacity of 167,000,000 cu ft a day during the winter months (or on the few days in summer when residue gas production is low) and as low as 10,000,000 cu ft a day (or less if necessary) during the summer months.

When the San Juan line is put into operation, residue gas utilization by El Paso Natural will rise to 320 billion cu ft per year. This is the equivalent, in fuel value, to 54,000,000 bbl of oil, an obviously great contribution to the conservation of natural resources. The company will pay, each year, to producers in the Permian Basin $19,150,000 for residue gas that, without the pipe lines, would represent only a nuisance and an economic loss. Thus, the San Juan Project will vastly improve the efficiency of the company's operations and will expand the benefits enjoyed by producers not only in the San Juan area, but in the Permian Basin as well.

Although the northern and southern pipe lines of El Paso Natural Gas Company will be operated as one integrated system and each will supplement the other, each represents entirely different problems in construction and operations. A summary of the construction activity of El Paso Natural Gas Company during the year just past can be most readily presented by discussing the programs on the southern and on the northern lines separately.

Southern Lines

Construction activity on the southern lines of El Paso Natural Gas Company increased the capacity of this system by nearly 50 per cent between March 1, 1950, and February 28, 1951. At the beginning of the year, the Permian Basin system of the company had daily deliveries of 660,000,000 cu ft (including field sales but excluding fuel gas); at the end of the year, capacity was 1081 million cu ft a day, not including fuel gas.

Most of construction activity during the year was devoted toward looping the company's already existing lines to the California-Arizona border. The company's crews put down nearly 500 miles of 30-in. pipe along the same right-of-way as that of the existing 26-in. and 30-in. lines. Little difficulty was encountered in this looping. Right-of-way had already been prepared when the previous lines were laid and the spreads were able to move rapidly forward as fast as pipe was delivered to them.

In contrast, one very important addition to the system was laid across some of the most difficult right-of-way that the company has ever encountered. Originating at a point near Quartzite, Arizona, a 120-mile long 30-in. pipe line was laid northward to Topock, Arizona, where a tie-in

Line-up crews at work on the 30-in. crossover line from Quartzite, Arizona, to Topock. Built during June, July and August, the line is the most isolated of any in the systems. This picture was taken nearly 100 miles from Kingman, Arizona, where the pipeliners lived when working on the line.

was made with the pipe lines of Pacific Gas and Electric Company. This line is known as the crossover line because, when the San Juan Project is complete, it will connect the northern and southern systems of the company. It was this crossover line that made possible the institution of natural gas service to northern California beginning in August of 1950.

The route of the crossover line is the most isolated of any part of El Paso Natural Gas Company's system. Working out of Salome, Arizona, and out of Kingman, spreadmen had to drive as much as 100 miles to get to and from work, a round trip mileage of 200 miles per day. The only roads were those built by right-of-way crews and the long, hot, rough ride placed great demands on the endurance of the men.

Eighty miles of the crossover right-of-way were through steep, precipitous mountains. Trucks and equipment could not be moved up and down these mountains safely under their own power, in many instances, and it was necessary to haul everything by cats for miles and miles.

Temperatures fell to 100 F on some days, but generally hovered at a good whacking 130 F. No rain fell in the several months that construction was in progress and none had fallen in the several months preceding. Movement of heavy equipment through the dry desert stirred up clouds of choking dust that not only caused discomfort but tended to clog machinery and to handicap work in other ways. El Paso Natural Gas Company, therefore, hauled water in large tank trucks and sprinkled the right-of-way from these trucks. This did not eliminate the dust problem entirely, but it alleviated the problem considerably.

The expansion program of El Paso Natural over the last several years has not only made it possible for natural gas deliveries to California to be instituted, but it has enabled the company to increase service to West Texas, New Mexico, and Arizona. The lateral lines from the 26-in. and 30-in. mainlines have, therefore, been an important part of the overall objectives of the company.

One of the more important of the lateral lines laid in the year past was a 31½-mile pipe line to Phoenix, Arizona, which has made it possible to expand deliveries of gas to that community. This particular line will serve, primarily, the Central Arizona Light and Power Company steam plant.

The Gila River, 12 miles from Phoenix, presented a highly challenging problem to the pipe line crews in putting down the lateral line. The "river" is actually a dry bed that flows with water only in the rainy season; however, immediately below the surface, water is found in great abundance. Ditches dug through here would fill with water almost at once and collapse.

El Paso Natural Gas Company crews met this problem by sinking well points deep into the soil at both sides of the pipe line route. Pumps were put into operation, drawing 4000 gal of water per minute; thus, water was removed from the ground faster than it was flowing, and the ditch remained water-free. The pumps were kept in continuous operation for six weeks, and the water removed by them was routed away from the ditch through pipe lines.

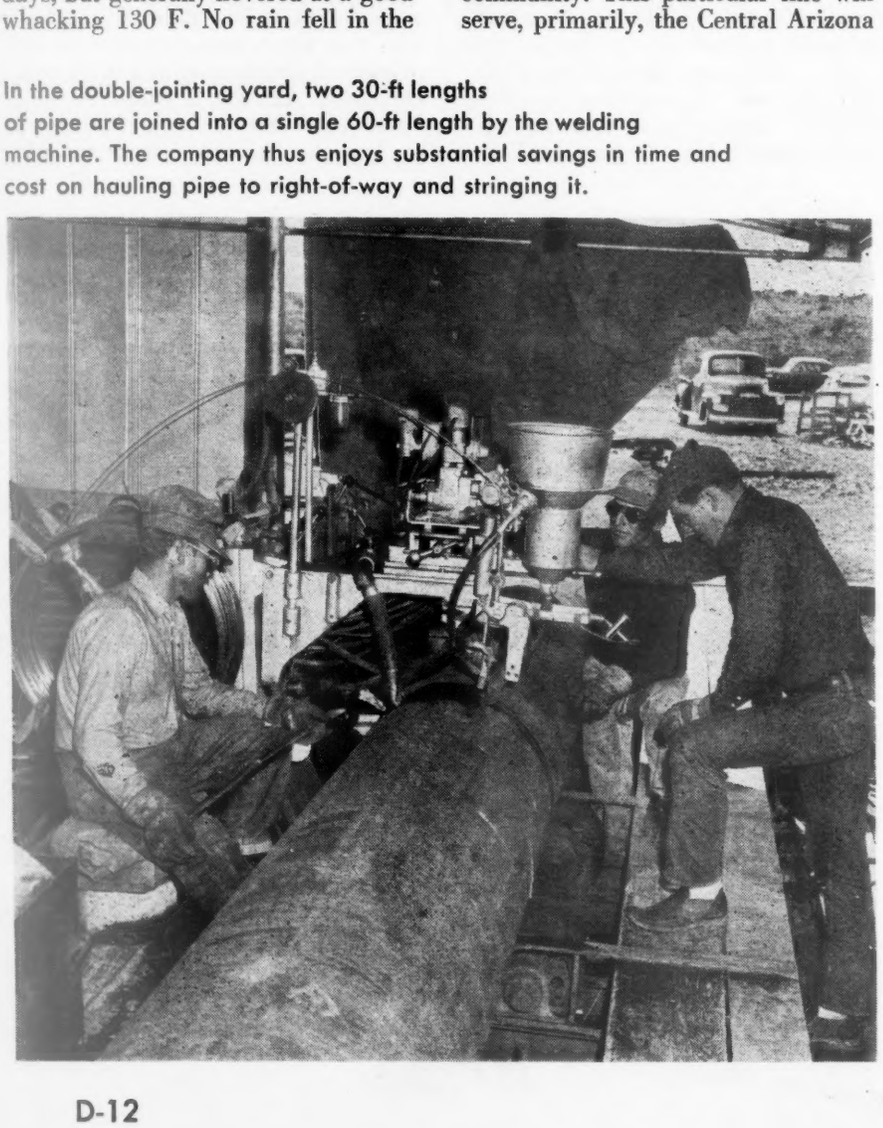
More than 500 miles of field lines were laid to connect gasoline plants (from which residue gas is purchased) and wells to El Paso Natural Gas Company's gathering lines and field transmission system. One of the largest, in length, of these lines was a 118 mile long pipe line 12¾ in. in diameter, from Synder, Texas, to the company's already existing lines at Goldsmith, Texas. This was the first line to provide a market for the residue gas of the great new fields at Snyder. Laid during the summer months, the pipe line crews were hampered by heavy rains and slowed down the necessity of boring dozens of road crossings. The line was completed well on schedule, however.

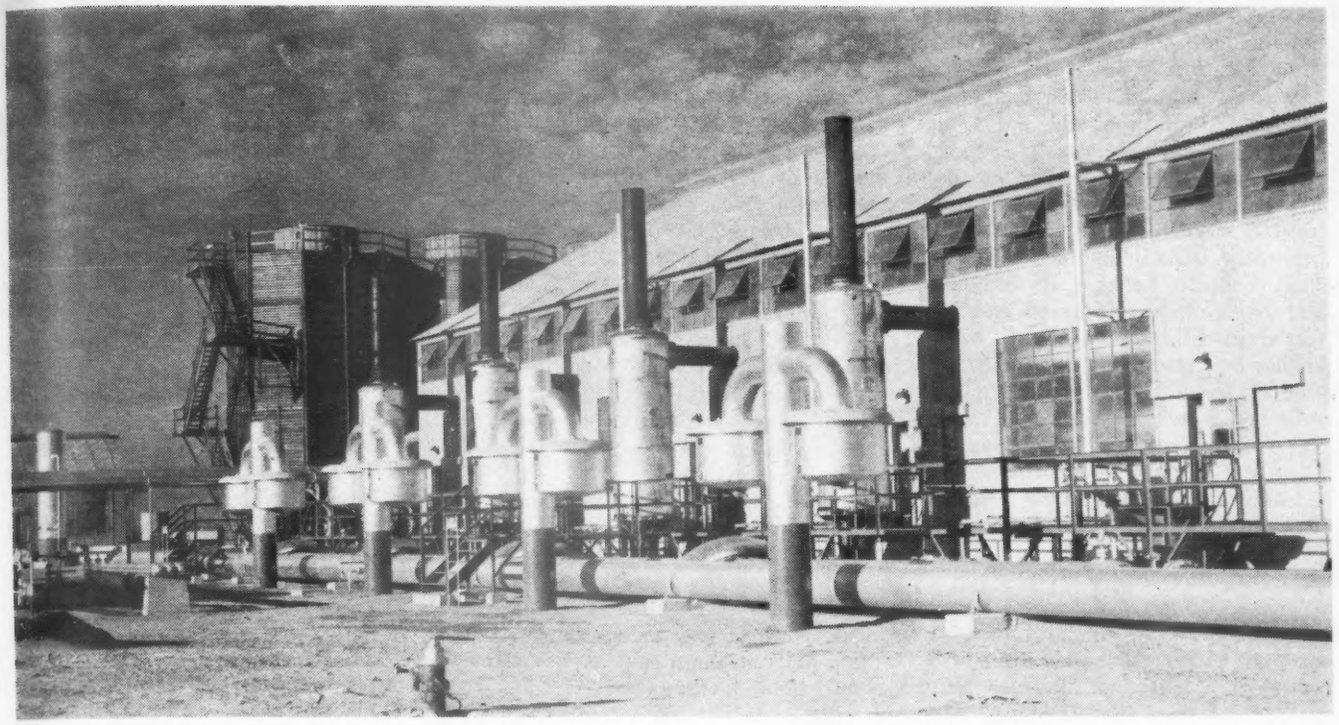
Significant additions were made during the year to plant facilities of El Paso Natural Gas Company. These included both new plants put into service and increased capacity at those already in operation. Compressor power throughout the southern system was increased 62,110 hp to give the system a total of 242,720 hp as of February 28, 1951. Treating plant capacity was increased by 127,788,000 cu ft a day (inlet sour gas) and gasoline plant capacity was increased by 96,788,000 cu ft a day.

New plants put into service during the year are as below:

Sealy-Smith Gasoline Plant in Ward County, Texas, has a design capacity of 16,510,000 cu ft of natural gas (inlet) a day and treating plant capacity of 15,790,000 cu ft a day. Its compressor facilities develop 3300 hp. The plant processes residue gas from oil wells in the Shell Sealy-Smith fields.

In the double-jointing yard, two 30-ft lengths of pipe are joined into a single 60-ft length by the welding machine. The company thus enjoys substantial savings in time and cost on hauling pipe to right-of-way and stringing it.





Keystone Main Line Compressor Station, completed in 1950, contains ten 1600 hp engines. It compresses 410,000,000 cu ft of gas per day.

Jal Plant No. 3 in Lea County, New Mexico, has a gasoline plant that will process 80,278,000 cu ft of natural gas a day; its treating facilities will process 74,315,000 cu ft of natural gas a day. Its compressor engines develop 5500 hp. Jal Plant No. 3 is operated in conjunction with Jal Plant No. 2 which lies about 2 miles distant. "Rich" treating oil from Jal Plant No. 3 is piped to Jal Plant No. 2 for distillation and the lean oil is, in turn, pumped back to Jal No. 3. The plant is unique in that it can process high pressure, intermediate pressure, and low pressure gas.

McElroy-Crane Plant in Crane County, Texas, receives residue gas from the Phillips gasoline plant nearby. It has treating capacity of 21,203,000 cu ft a day of low pressure gas and 16,480,000 cu ft a day of high pressure gas, or a total capacity of 37,683,000 cu ft a day. Its compressor engines develop 4400 hp.

Keystone Mainline Station in Winkler County, Texas, is a compressor station receiving gas from the various plants in the Benedum fields (Keystone, Goldsmith, McElroy-Crane, Sealy-Smith, and others) and handling final compression on that gas before delivery into the main lines of the company. Pressure is raised from about 525 psi to 830 psi. The plant has a total horsepower of 15,000.

Hobbs Field Plant in Lea County, New Mexico, is a small field plant situated on the site of the Phillips Hobbs gasoline plant. Receiving untreated residue gas from the Phillips plant, Hobbs plant compresses this gas for transmission to Monument plant and then to Eunice plant where the gas is treated and dehydrated. It is operated as a part of the Eunice plant even though it is many miles distant. It has 2200 hp.

Monument Plant in Lea County, New Mexico, receives natural gas from the Hobbs plant and from the Warren plant and from the Phillips Lea plant. It compresses this gas for transmission to the suction side of the Eunice treating plant where, of course, the gas is processed. It has 4400 installed horsepower. It is operated as a part of the Eunice plant.

Dimmitt Mainline Station in Lamb County, Texas, is a compressor plant built to increase the effectiveness of the 24-in. field transmission line from Dumas, Texas, to the Eunice, New Mexico, plant. It develops 4050 hp.

Snyder Field Station in Scurry County, Texas, develops 2640 hp. This engine compresses gas from the Snyder fields for transmission to the Goldsmith plant of El Paso Natural Gas Company, 120 miles distant, where this gas is processed.

Bedford Field Station in Andrews County, Texas, is a small field station that delivers gas to the Jal Plant No. 2 of El Paso Natural Gas Company.

Mainline compressor power of El Paso Natural Gas Company was increased by 20,520 hp. This power was distributed among stations as follows: Guadalupe station, Culberson County, Texas, 5600 hp; El Paso station, El Paso County, Texas, 3800 hp; Deming station, Lunca County, New Mexico, 3300 hp; Willcox station, Cochise County, Arizona, 3520 hp; Tucson station, Pima County, Arizona, 2200 hp, and Gila station, Maricopa County, Arizona, 2100 hp.

A great deal was accomplished during the year in the construction of pipe line bridges along the southern lines. Although these bridges did not add materially to the capacity of the southern lines, they do provide an extremely sound protection against flood damage and represent a valuable addition to the system.

At the Pecos River crossing near Malaga, New Mexico, the company completed and put into service a truss type, roadway bridge. This bridge supports two 30-in. pipe lines and one 16-in. pipe line and provides a roadway that is 20 ft wide. Immediately adjacent to this roadway bridge are two suspension bridges that have been in service for several years.

At the San Pedro River, near Benson, Arizona, a second pipe line suspension bridge was completed and put into service during the year. The new bridge supports 30-in. pipe; the old bridge supports 26-in. pipe. Both bridges are 1020 ft long and 105 ft high.

A major part of the work on a second suspension-type bridge at the Gila River crossing near Buckeye was

accomplished during the year. This new bridge, like the older one at the same location, will be 2100 ft long and 137 ft high. The new bridge will support 30-in. pipe; the old bridge supports 26-in. pipe.

A suspension type bridge was constructed over the Bill Williams River for the 30-in. crossover line to San Francisco. This bridge is 980 ft long.

At Topock, Arizona, an old highway bridge was purchased and converted to a pipe line bridge. This bridge is a steel-arch, steel approach type bridge and is 832 ft in length. It is owned jointly by El Paso Natural Gas Company and Pacific Gas and Electric Company and provides the crossing over the Colorado River between Arizona and California.

San Juan Project

The San Juan project will consist of about 450 miles of 24-in. mainline together with related gathering lines, lateral lines, and plant facilities. Originating in San Juan County, New Mexico, it extends southwest across northern Arizona to Franconia, Arizona, where, when complete, a tie-in will be made with the crossover line from the southern system of the company.

Natural gas for this pipe line system will be drawn from three sources within the San Juan Basin, the region surrounding Four Corners where the states of Utah, Colorado, New Mexico, and Arizona meet. These three sources are Barker Dome, Blanco field, and Angel Peak-Kutz Canyon fields.

Under present planning Barker Dome will be the major producing area of El Paso Natural Gas Company in the San Juan Basin. El Paso Natural's acreage lies about 35 miles northwest of the city of Farmington, New Mexico, and straddles the New Mexico-Colorado line with about half the acreage lying in each state. El Paso's acreage lies within the Ute Indian Reservation and was obtained by lease from the Ute Indians. The Utes, therefore, will receive royalty payments on all gas produced.

Barker Dome is a large anticline with its east-west axis located approximately along the Colorado-New Mexico state line. Wells are producing from the Paradox formation, which is a fractured dolomitic member of the Pennsylvania age at the approximate depth of about 9700 ft.

Barker Dome wells have unusually high potentials, 150,000,000 to 400,000,000 cu ft a day after acidation. Shut-in pressure is about 2800 psi. The gas is 16 per cent acid gases—15 per cent CO_2 and 1 per cent H_2S. El Paso Natural plans peak production from this field of 110,000,000 cu ft a day.

Blanco field is located in a very highly eroded area. It is anticipated that laying of gathering lines will involve considerable difficulty because most of the wells will be drilled on top of a series of unconnected mesas. The sides of these mesas are high and very steep and will be difficult to surmount. Wells in the Blanco field vary in potential from 500,000 to 8,000,000 cu ft a day with shut-in pressure in the 1100-psi range.

The producing zones are from a large syncline that extends about 20 miles east and west and an estimated 60 miles north and south. The reservoir is a stratographic trap that was formed by contamination of the sands in the reservoir.

Gas from the Blanco field is very sweet, and it is planned to use this gas, without processing, direct from the wells to serve northern Arizona until plant facilities are complete.

Major producing zone in the Kutz Canyon-Angel Peak area is the Pictured Cliff sandstone, which is found at a depth of about 2200 ft and varies in thickness from 80 to 200 ft. Customary practice is to drill to the top of the pay zone with rotary rigs, then use cable tools, and finally shoot the wells.

Potentials vary from 250,000 to 3,000,000 cu ft a day with most of the wells being less than 1,500,000 cu ft a day. Shut-in pressures are in the 500 to 600-psi range. The gas is sweet and has a good hydrocarbon content, which, it is estimated, will provide about 1 gal recovery of 26-lb gasoline.

The largest plant planned for the San Juan project is the San Juan River Plant, which is being built near Fruitland, New Mexico. Natural gasoline extraction facilities at this plant will process about 60,000,000 cu ft of gas a day and will handle gas from the Blanco and Angel Peak-Kutz Canyon fields. Gas from Barker Dome is extremely lean and will not require processing for gasoline extraction.

On the other hand, Barker Dome gas will be passed through purification facilities and the gas from the other fields will not. Compressor power at the San Juan River plant will amount to 4200 hp and will deliver the gas into the mainline at a pressure of 810 psi.

At Angel Peak, a small field compressor station and a dehydration plant will be built. This gas will be delivered into a 16-in. line, 40 miles in length, which will extend to the Blanco and Angel Peak areas from the San Juan River Plant.

One mainline compressor plant, Navajo station, is being built near Ganado, Arizona. This station will develop 5000 hp.

The route of the 24-in. mainline of the San Juan project was not planned according to the usual practice of following a straight line. Much of the terrain in this area is entirely inaccessible, and there are high mountains and deep canyons that provide formidable obstacles. The pipe line was laid out to avoid, so far as possible, the most difficult natural obstacles. Finally, there are many national monuments in the region and it was thought best to avoid these as much as possible.

The route finally selected by the company crosses 225 miles of the Navajo Indian Reservation. It just misses the Painted Desert National Monument and crosses 60 miles of the heavily wooded land of the Coconino and Yavapai National Forests. Elevations along the route vary from 1100 ft near Topock to 7800 ft near Flagstaff.

All types of land control were encountered in negotiations for right-of-way. There are privately owned lands, state lands, United States lands (public domain), national forests, Indian Reservations, Indian allotments both inside and outside of reservations, Indian Tribal lands, long term leases, and practically all other types of ownership and control.

Among the more interesting and unusual negotiations were those with the Navajo Tribal Council concerning right-of-way across the Navajo Indian Reservation. The Navajo Tribal Council is, for all practical purposes, the representative government of the Navajo people.

Among other things, the Navajo Tribal Council asked that Navajos be employed on the Navajo Reservation for all jobs for which they qual-

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FPC has authorized Michigan Consolidated Gas Company, of Detroit, Michigan, to acquire from Austin Field Pipe Line Company, its wholly owned subsidiary, also of Detroit, natural gas pipe line and compressor facilities in Michigan.

The facilities include a 24-in. pipe line extending about 140 miles from the Austin storage field in West Central Michigan to Detroit, and a metering and regulating station at the Detroit terminus of this line. These facilities were built by Austin and are now operated by Michigan Consolidated under lease. Michigan Consolidated also will acquire from the Austin company a compressor station in the Austin storage field.

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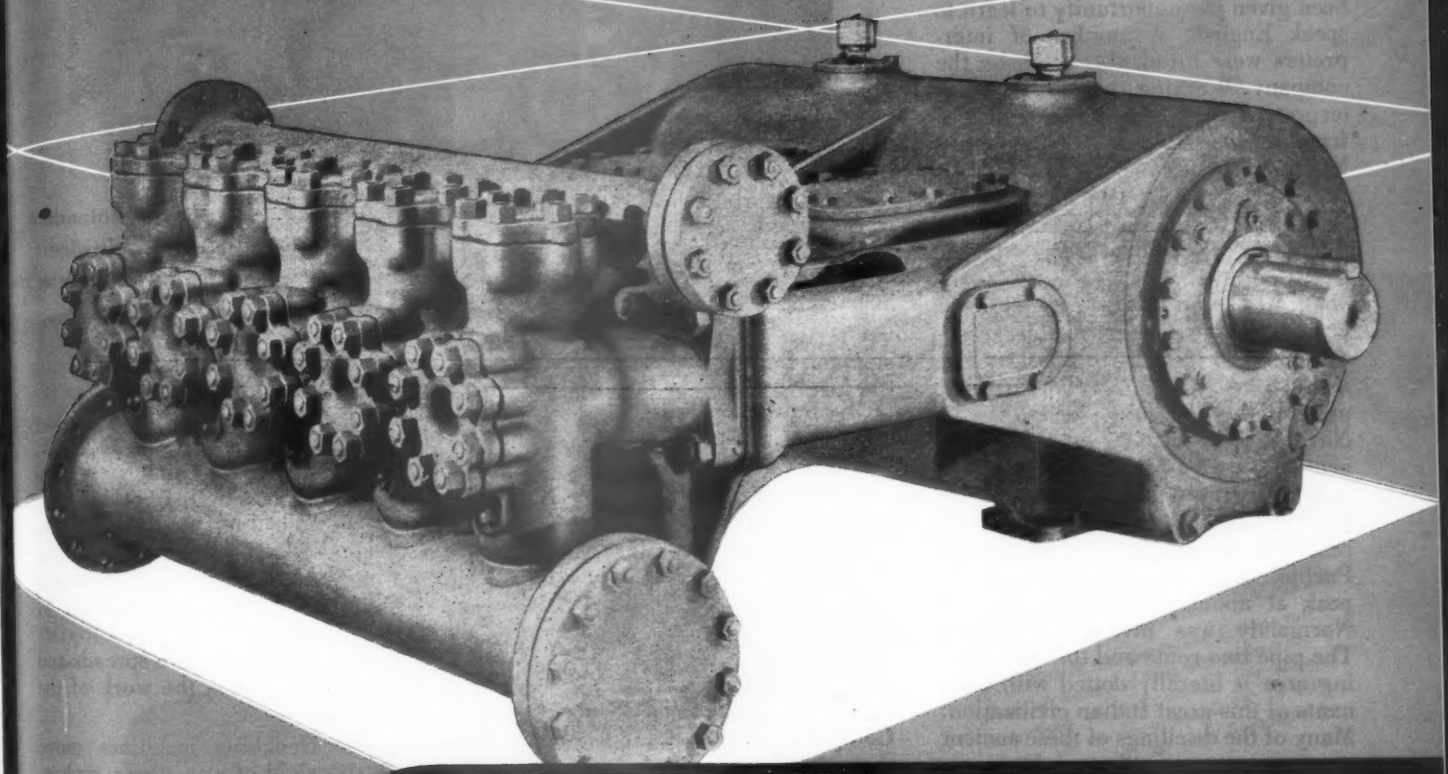

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Bbls. per hour. . .	218	327	436	545	656
Pump RPM	50	75	100	125	150
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ified. The company agreed to do this and to train the Navajos so that they could be up-graded as the opportunity arose. Navajos employed by the company have proved to be extremely valuable.

The only difficulty encountered in working with the Navajos is that 80 per cent of these people have never been given the opportunity to learn to speak English. A number of interpreters were hired, therefore, by the company. Working through these interpreters, the experienced pipeliners from the southern lines of El Paso Natural Gas Company were able to train the Navajos quite readily.

El Paso Natural Gas Company found the Navajos to be very industrious, quick to learn, and dependable. About half the laborers have been up-graded to rock drill operators, tractor operators, timekeepers, and similar jobs. When the San Juan project is completed, a number of Navajos will be retained in permanent, full-time operating jobs.

The area through which the San Juan pipe line is being built was the center of the great American Indian Pueblo civilization, which reached its peak at about the time William of Normandy was invading England. The pipe line route and the surrounding area is literally dotted with remnants of this great Indian civilization. Many of the dwellings of these ancient people are now beneath the surface, having been covered through the centuries by soil and volcanic ash.

C. L. Perkins, extreme right, vice president and general superintendent of El Paso Natural Gas Company, meets with a group of Navajo pipeliners. Next to him, wearing glasses, is Herbert Tsosie, interpreter.

Federal statutes provide that ruins and other items of archaeological and historical interest cannot be disturbed except by permission and under proper procedures to preserve the value of the material. This protection is provided under the Law of Antiquities, which was passed in 1908.

Working with officials of the National Park Service and other government agencies, El Paso Natural Gas Company developed procedures that observe, fully, the provisions of the Law of Antiquities and that, at the same time, reduce to a minimum any delay in pipe line construction. Dr. Jesse L. Nusbaum, senior archaeologist of the National Park Service, serves as consulting archaeologist to El Paso Natural Gas Company. Under his direction, five archaeologists have been placed on the payrolls of the company. Two archaeologists work with each of the two spreads and the fifth coordinates the work of the two teams.

Before trenching machines move down the right-of-way, these archaeologists make surface surveys. From such bits of evidence as pieces of pottery, arrowheads, and the like, they can frequently determine that a former Indian dwelling lies beneath the surface. Also, frequently, they find remnants of abandoned hogans and other structures on top of the ground.

After surface surveys are completed, the construction equipment moves forward. The archaeologists follow the ditching machine, closely examining the dirt that it turns up. Frequently the profile of an abandoned dwelling, usually a pit house, is seen in the sides of the ditch. Or, again, the ditcher may turn up pottery, cooking utensils, and other such remnants.

When an archaeological site is discovered, proper steps are taken to excavate the material carefully and to make full scientific notes. If necessary, the archaeologists hire at company expense whatever labor is needed to complete an excavation before arrival of construction crews.

In the event that a major site is discovered — a large pueblo of many rooms, for example—that would require weeks of digging and excavation, Doctor Nusbaum is authorized

Jesse Williams (kneeling and with light hat) right-of-way agent of El Paso Natural Gas Company, purchases right-of-way from a Navajo Indian family. After securing right-of-way across the entire Navajo Indian Reservation from the Navajo Tribal Council, the company then had to secure right-of-way across individual allotments within the reservation from the families holding those allotments. Standing at the far right is John Watchman, interpreter. Standing behind the little girl is Henry Taliman, also an interpreter.

Additive for light petroleum products

CHECKS CORROSION

TESTS PROVE that Santolene C stops rust in fuel oil. Results of tests with various concentrations of the additive are shown above. (A) No Santolene C. (B) 10 ppm Santolene C. (C) 20 ppm Santolene C.

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SERVING INDUSTRY . . . WHICH SERVES MANKIND

Francis Cassidy and Bill Bullard, archaeologists of El Paso Natural, examine specimens of early Indian pottery found on the right-of-way of the main line of the San Juan Project. Carved into rock in background are some "modern" Navajo drawings dating back to 50 or 100 years ago.

to re-route the pipe line around the site. This is, perhaps, the first time in the pipe line industry that one man has represented both the grantor and grantee of a right-of-way easement.

Some 300 sites of major interest have been found, and more than 80 excavations have been made. The structures discovered range from small early developmental pueblo sites dating from 700-900 A.D. to the larger multiple-roomed surface structures. There were also a number of subterranean pit houses of the period of about 900 to 1150 A.D.

The material uncovered by the pipe line crews has been of much interest to archaeologists. All of it is being placed with appropriate museums. A complete report is being made on the archaeological survey of the line, and it is felt that much information will be developed from a study of the materials. The project attracted much attention, and the company felt that it was valuable enough to be continued not only on government lands, as required by law, but on privately owned lands.

In addition to the archaeological work, geologists have welcomed the opportunity to examine the trench banks through the sandstone west of the Little Colorado River crossing and the Chinli clays east thereof for evidence of related plant and animal fossils, both vertebrate and invertebrate.

Working has moved rapidly ahead on the San Juan project. Permission to construct the system was granted by Federal Power Commission on July 14, 1950. Right-of-way clearing, rock ditch work, and other preliminary construction were underway by August 2, 1950. Pipe was first received in Gallup, New Mexico, on September 1, 1950, and since then pipe line construction has kept pace with pipe deliveries.

By March 1, 1951, more than 320 miles of 24-in. mainline were underground. Plants, houses, office buildings, and other such facilities were well underway and many were nearly complete. It is anticipated that all of the mainline will be laid by early summer, and that all facilities will be completed by early fall.

Lateral lines from the mainline were completed to Holbrook and Winslow, and nearly so to Flagstaff, Williams, and Seligman on March 1. From a physical point of view, natural gas service could be instituted to these communities by the middle of March. At the time this is written, however, it is anticipated that inception of deliveries will be delayed because the Department of the Interior has not yet granted right-of-way across federal lands.

The San Juan project represents a major challenge to the construction crews of El Paso Natural Gas Company. It crosses all types of terrain—mountains and flatlands, desert and forest, rock and sand. There were, for example, more than 160 miles of rock through which right-of-way and ditch had to be blasted. This required about 2,000,000 lb of dynamite. Unusual for El Paso Natural Gas Company was the necessity to clear timber from its right-of-way. The timber varied from thick, enveloping underbrush to tall, towering pine trees. It was decided to turn over the clearing of timberland to company personnel rather than to hire outside professional lumberjacks. Welders' helpers, truck drivers, and others who never before had cut timber soon became proficient in this art.

Much credit belongs to the construction crews. The Navajos, despite the language handicap, learned the jobs quickly and well, and hustled like long-time pipeliners within a few weeks. The experienced men from the southern lines provided excellent leadership in knitting the Navajos into well coordinated, smoothly working teams. The project was, as has been said, a big challenge. It is moving along, however, well ahead of schedule. ★ ★ ★

Excavating a pit-house found beneath the surface of the right-of-way main line of the San Juan Project. The pit-house, which dates to about 1100 A. D., was found near Flagstaff, Arizona.

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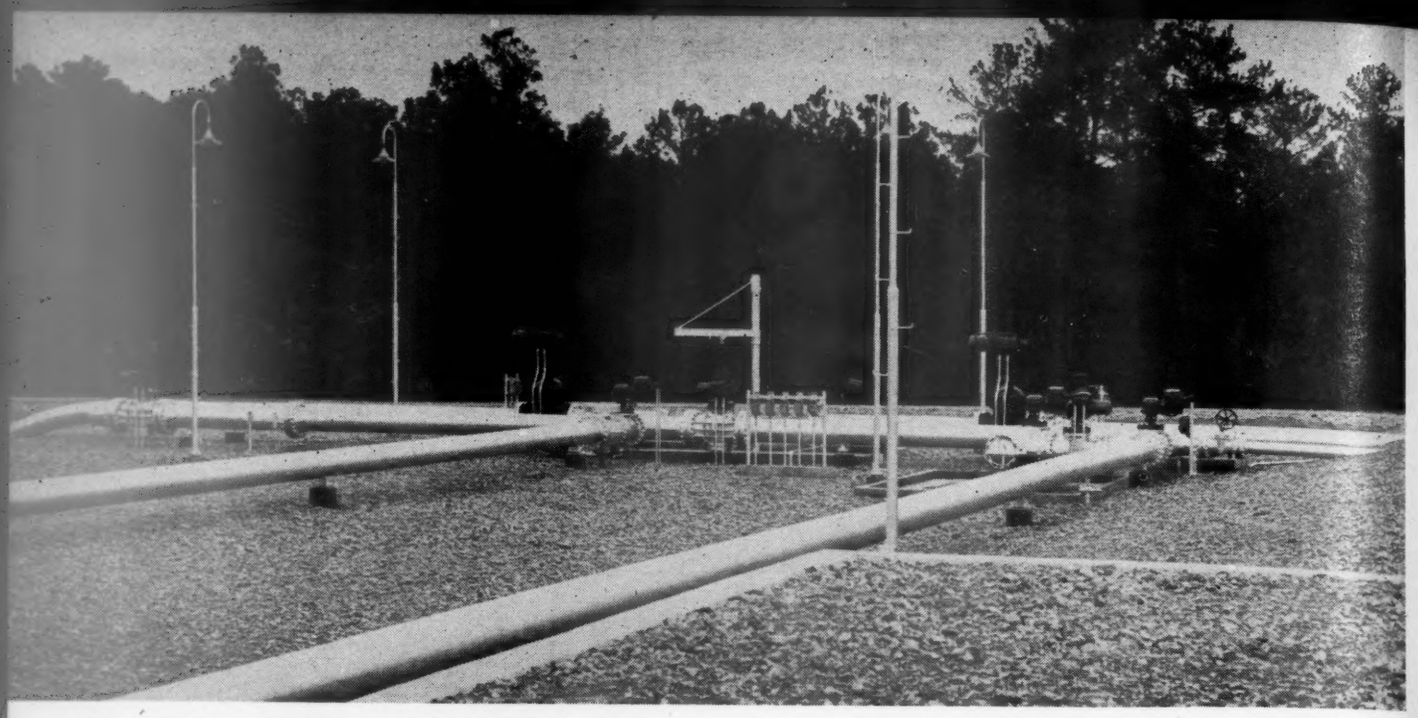


Scraper traps and station manifold at Warda Station.

EXCLUSIVE P 615.51

Design of Oil Pumping Stations

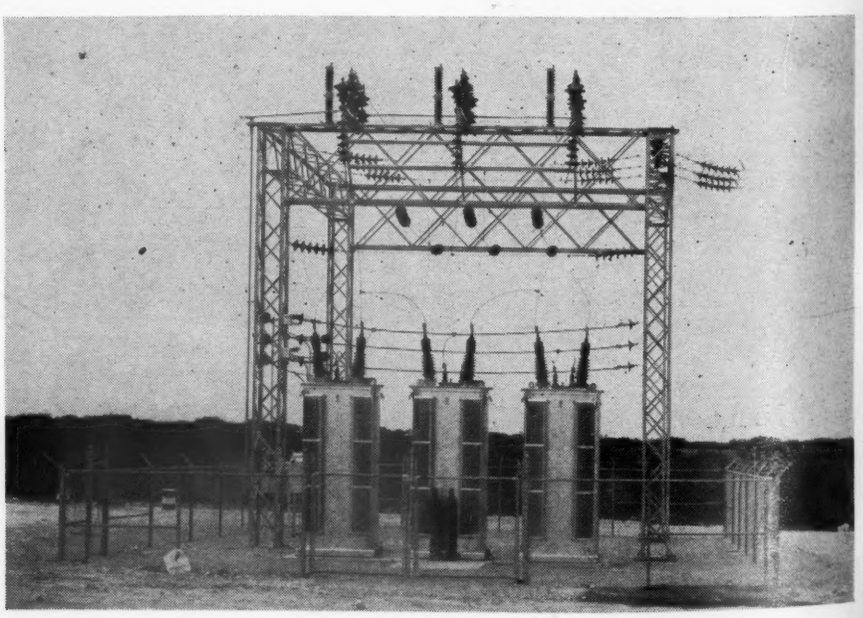
Installations on Humble's 18-in. Kemper-Satsuma line are typical modern equipment and practices

FRANK H. LOVE*

MODERN crude oil pumping station design and operation are typified in three new installations completed within recent months by the Humble Pipe Line Company. The new units are at Fort McKavatt, Eckert, and Warda, on the 18-in. system constructed last year between Kemper station in West Texas and Satsuma in the Gulf Coast area. Kemper is the originating point for the 18-in. line. It is, as a matter of fact, the terminal point for all of Humble's West Texas crude, which is sent from there to various points according to refinery needs. One line out of Kemper takes oil to Ingleside in the Corpus Christi area. The new 18-in. line transports it to Satsuma, which is a terminal point for this crude as well as crude from East Texas, the Texas Panhandle, and West Texas fields. From there most of the oil goes to the company's Baytown refinery; some of it, however, goes to Webster station. At Kemper and Satsuma facilities have been expanded to take care of the increased tonnage occasioned by the new line. Motor-driven centrifugal pumps have been installed on the discharge line at each point.

The new line, on which these three new stations have been constructed, was laid to shorten an older system that went from Kemper through north central Texas, then southward to Satsuma and Baytown, a route that was necessary at the time to serve particu-

*Editor, Oil and Gas Pipelining.



Electrical sub-station serving Humble Pipe Line's Ft. McKavett station.

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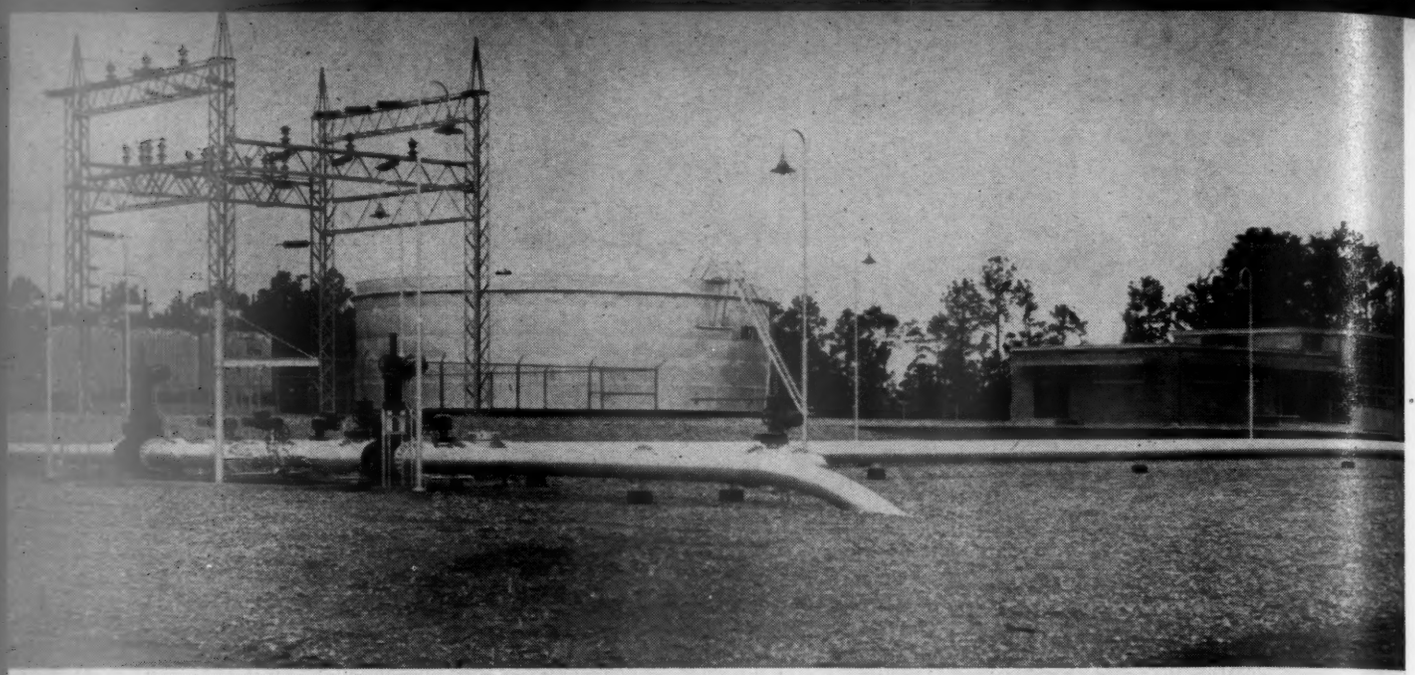
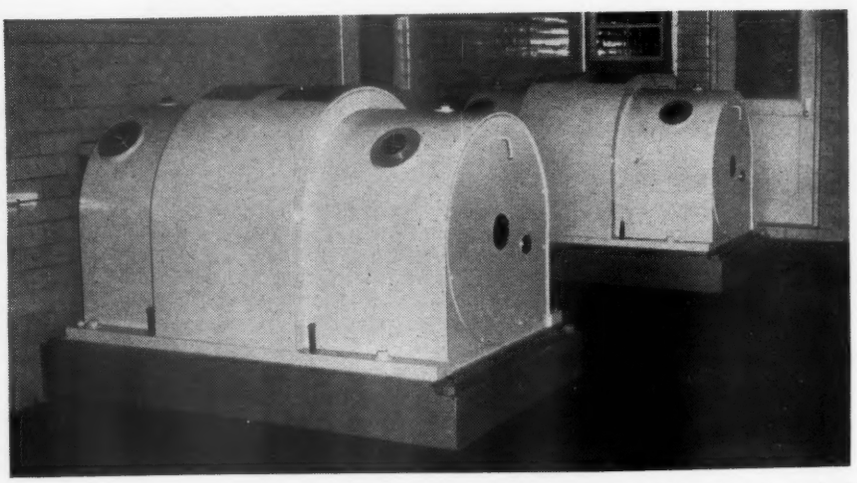


Warda station showing microwave tower, scraper traps, electric sub-station, station building, storage tank.

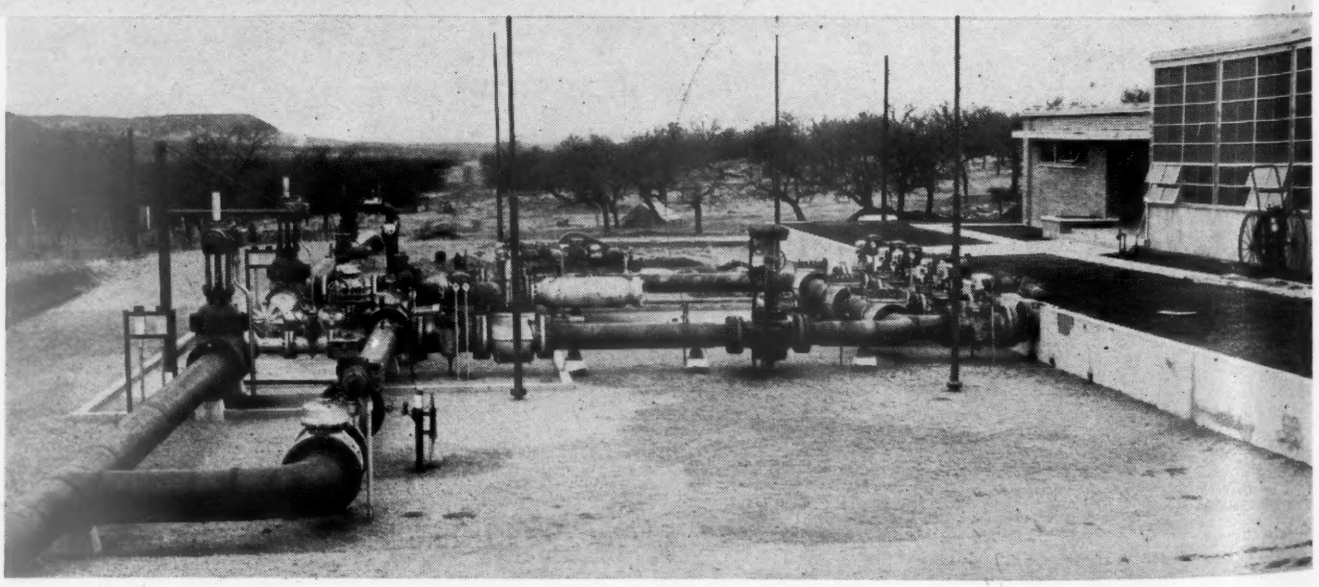
lar fields. By laying the 370-mile, 18-in. line direct from Kemper to Satsuma, the total distance was reduced by 52 miles. The overall economy effected by the new system is due to this shortening of the distance the oil has to move, to an increase in capacity, and to reduction in the number of pumping stations. In addition to these considerations, the system has an added value that was not foreseen at the time plans were initiated—its contribution in the present critical situation that finds the crude oil supply tightening.

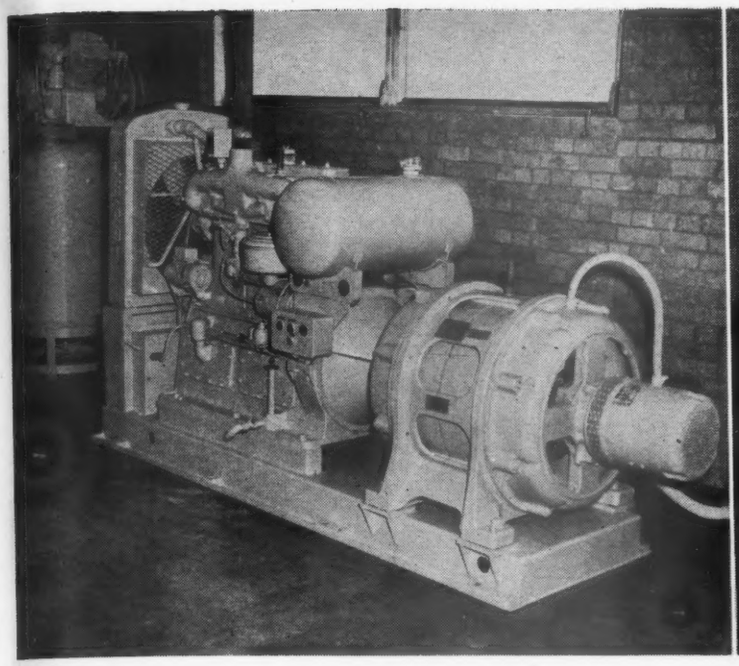
At the outset, it was anticipated that initial requirements could be met



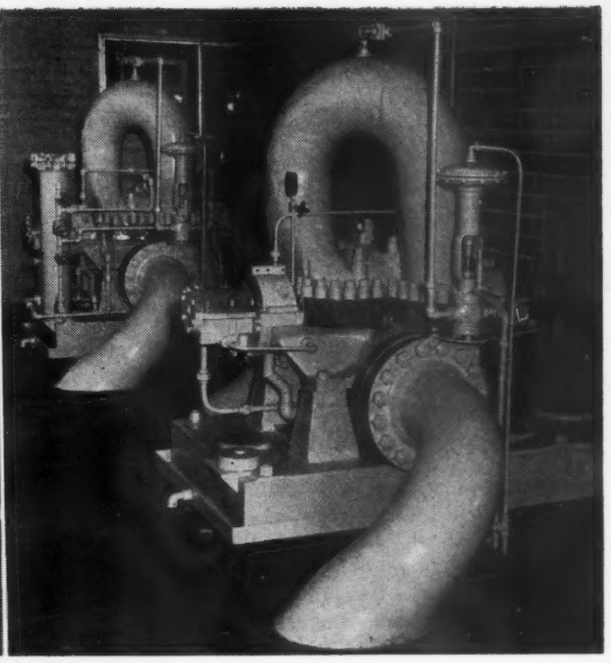
Typical 1000-hp motor installation at each of Humble's three stations on its 18-in. line from Kemper to Satsuma.

Scraper traps and station manifold at Eckert Station.





View of 25-kw auxiliary generator with starting air compressor in corner. Typical of installation at all three of Humble's pump stations on the Kemper-Satsuma line.



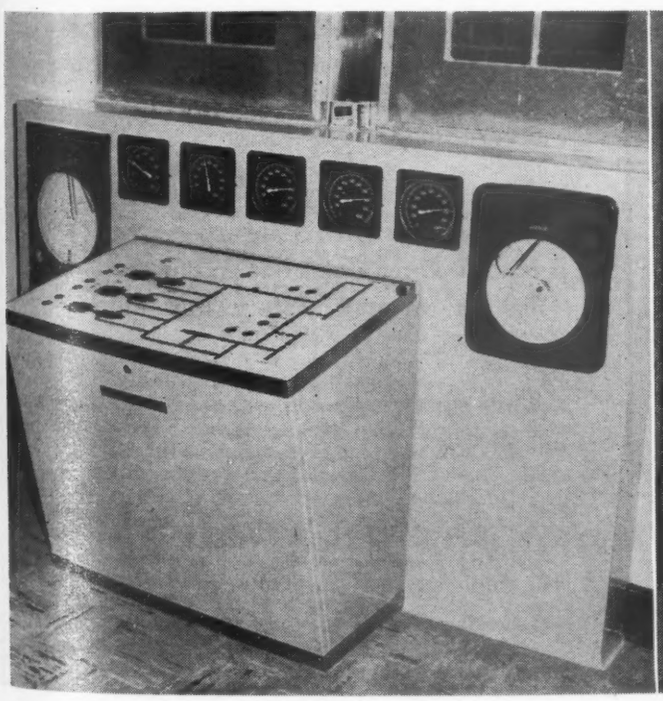
Typical view of main line pumping units, Humble Pipe Line's Kemper-Satsuma line.

with construction of one intermediate station, at Eckert, the stations at Fort McKavatt and Warda to be built at a later time. Before the Eckert station was completed, however, plans were changed and work was begun on the other two. In addition, it was decided that a third pumping unit should be installed at each.

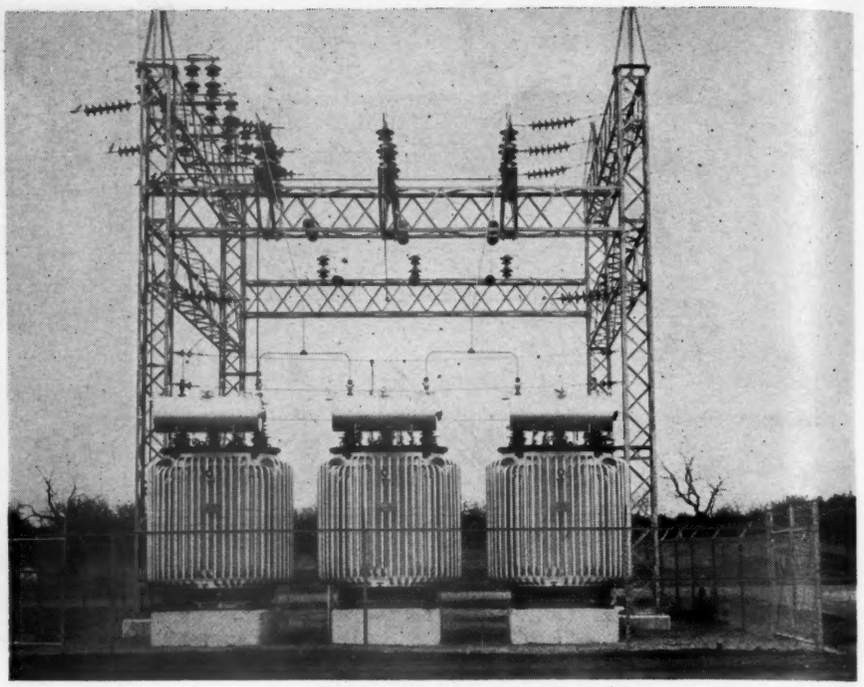
The three stations are now operating at a maximum pressure of 800 psi, and with two pumping units each are moving about 128,000 bbl of crude oil a day. The foundations are poured for the third units and when these are in service the capacity of the line will be increased to 136,000 bbl a day.

The pumping units consist of 1000-hp, 230-volt induction motors direct connected through a flexible steel coupling to 2-stage centrifugal pumps. The two units operate in series to increase the suction pressure from 25 psi to a discharge pressure of 700 psi. The third pumping unit will consist of a 500-hp motor driving a single-stage centrifugal pump, which will operate in series with the two larger units and will increase the total sta-

Control center is typical of installations at all three pump stations.



Electric control panels are typical of installations at all three stations.



Electrical sub-station serving Humble Pipe Line's Eckert station on the Kemper-Satsuma 18-in. line.

tion pressure differential to approximately 800 psi. All pumps have mechanical seals.

Air for cooling the motors is pulled in from the outside by a fan situated in the motor assembly, entering the base through a duct beneath the floor and being discharged at the top of the motor. Louvers are situated in the wall on the outside of the building and filtering elements are in housings just inside the building.

Prior to entering the pumps the oil stream passes through a strainer for removal of any foreign material, which might damage moving parts. On the discharge side of the station, a control valve operates automatically to regulate pressure in accordance with varying line conditions, which may be caused by a change in temperature or in the grade of the oil being pumped.

The line operates as a closed system; however, at each station a 30,000-bbl tank has been erected into which oil can be pumped in event a gate should be closed against the stream. A relief valve on the incoming line automatically discharges the oil into the tank in such an eventuality. Oil is pumped from the emergency tank into the suction of the mainline pumps, or directly into the main line, by means of a reciprocating type pump situated outside the station building. Design of the system is such, also, that any of the stations may be bypassed should it become necessary.

The central control point of the station is the console or control desk, which is in the office. An operator at

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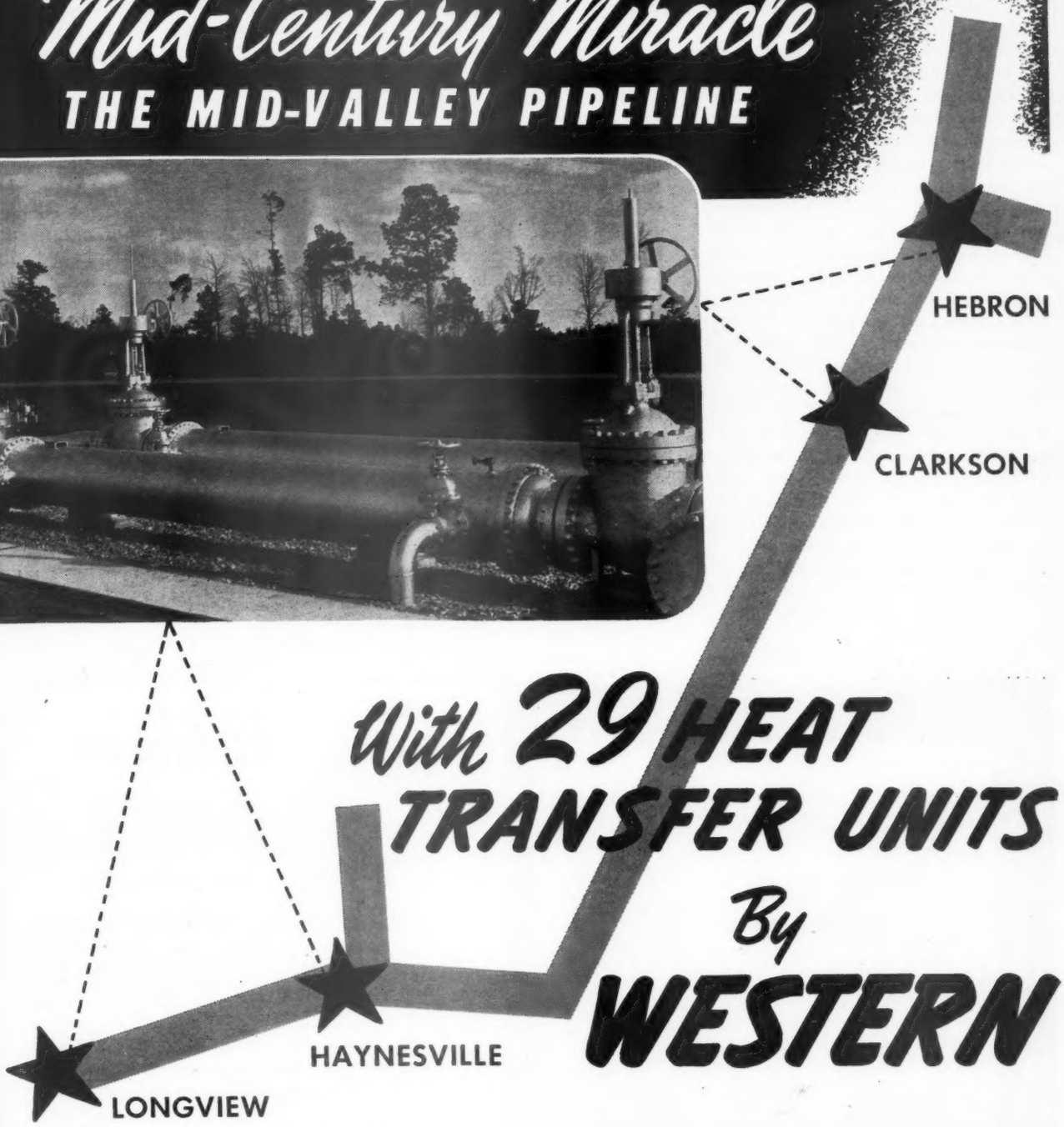

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this desk has a full view of both the motor and pump rooms through glass paneling. Upon the lucite-topped desk is a schematic layout of the station piping and equipment. Lights on the desk indicate the open or closed position of valves in the station piping. Main pumping units are started and stopped by means of pushbuttons, and it is here that pressures, rates of flow, and the operation of safety devices are either recorded or indicated.

To start a pumping unit the operator has but to press the button for that particular unit, the rest is done automatically. When he presses the button, a motor-operated suction valve begins to open and completes its opening in 60 sec. When the valve becomes fully open, an auxiliary contact initiates the starting of the pump motor. When the motor attains full speed, the motor-operated discharge valve begins to open, and in 60 sec is completely open. So exact and dependable are the starting controls that should the discharge valve not be in a closed position the unit will not begin the starting sequence. Also, if for any reason the sequence of starting a unit is interrupted, the motor-operated valves will return to the closed position after termination of the sequence time.

Furthermore, the pumping units are prevented from starting if suction pressure is insufficient at the time the suction valve is in full open position. This protection is provided by a pressure switch set at the desired minimum pressure. The switch, in addition to preventing starting when pressure is inadequate, also will shut the unit down if it already is in operation when the pressure drops. When the switch operates for either of these reasons, a station alarm is sounded and a red light shows on the control desk, revealing the exact nature of the trouble.

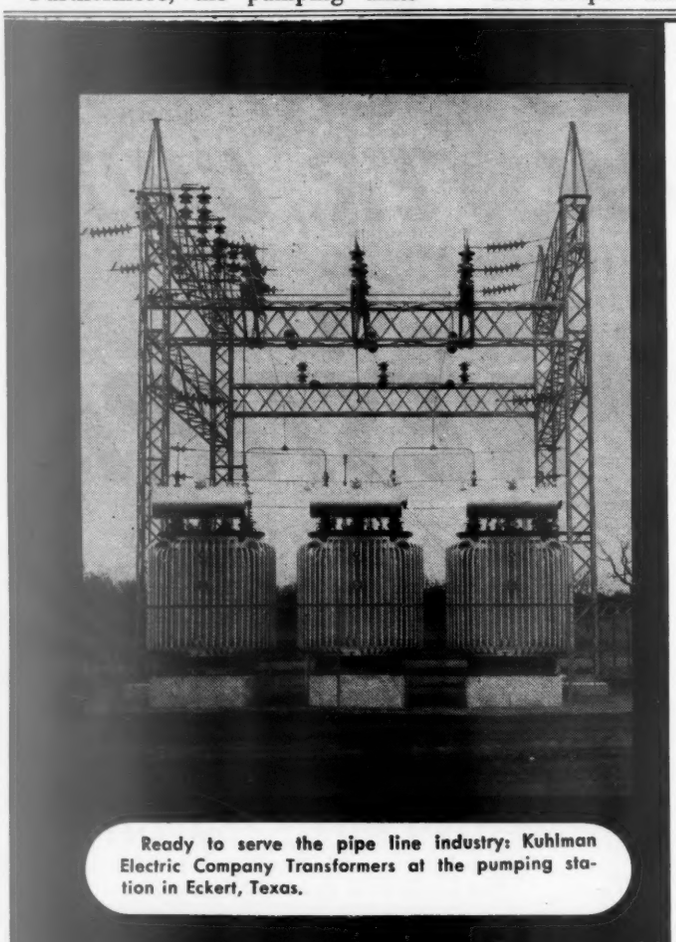
On each of the pumps there is a temperature switch that protects the pump from excess heat that might be generated under abnormal operating conditions. These protective devices will sound the station alarm and indicate on the control desk the device that has functioned. Temperature switches are also provided on the motors. Excessive motor winding temperature will not shut the pumping unit down but will sound an alarm and light the proper light.

With such automatic equipment in use it is necessary to have only one engineer on duty at a time, but in addition, the chief engineer, who lives in a company house at the station site, is on call 24 hours a day.

The compact nature of the motor-driven centrifugal pumping units as used at these three Humble stations has made possible the adoption of station buildings typifying the best in modern functional design. They are built on a concrete beam foundation. The section housing the office and auxiliary equipment is constructed of 8-in. brick masonry. The section housing the pumps and motors is of steel frame construction covered with corrugated asbestos. Inside walls are of glazed ceramic tile. Between the motors and pumps is a masonry firewall. The roof is a precast concrete slab. Building trim is of stainless steel and the windows are equipped with glare-reducing glass.

Electric power is purchased from the West Texas Utility Company and the Lower Colorado River Authority. At each station there is a sub-station to reduce the voltage from 66,000 to the 2300 volts required by the motors. For emergency purposes a 25-kw generator driven by a gas engine has been provided.

Scraper traps are installed at each station, one on the incoming line so that basic sediment and scale may be removed, and one on the outgoing line for insertion of a scraper or "pig" to clean the next section of line. These pigs are run approximately every 30 days. ***



Ready to serve the pipe line industry: Kuhlman Electric Company Transformers at the pumping station in Eckert, Texas.

Kuhlman

is proud to serve the pipe line industry

• Hats off to the pipe line industry! Its present vigorous program of new line construction is making both oil and gas readily available to industry and for private use everywhere in the nation.

And we're proud to announce that Kuhlman Electric transformers were chosen by West Texas Utilities Company to serve the new crude oil line from West Texas to the Gulf Coast at the Eckert, Texas, pumping station. Another example of the many ways in which Kuhlman transformers have been working to make America great for more than fifty years.

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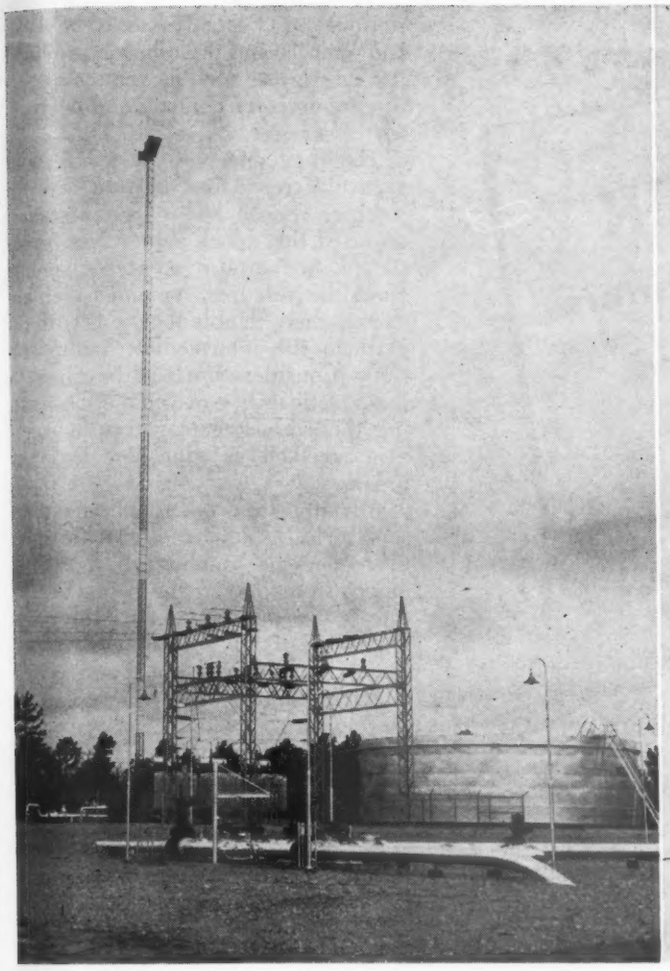
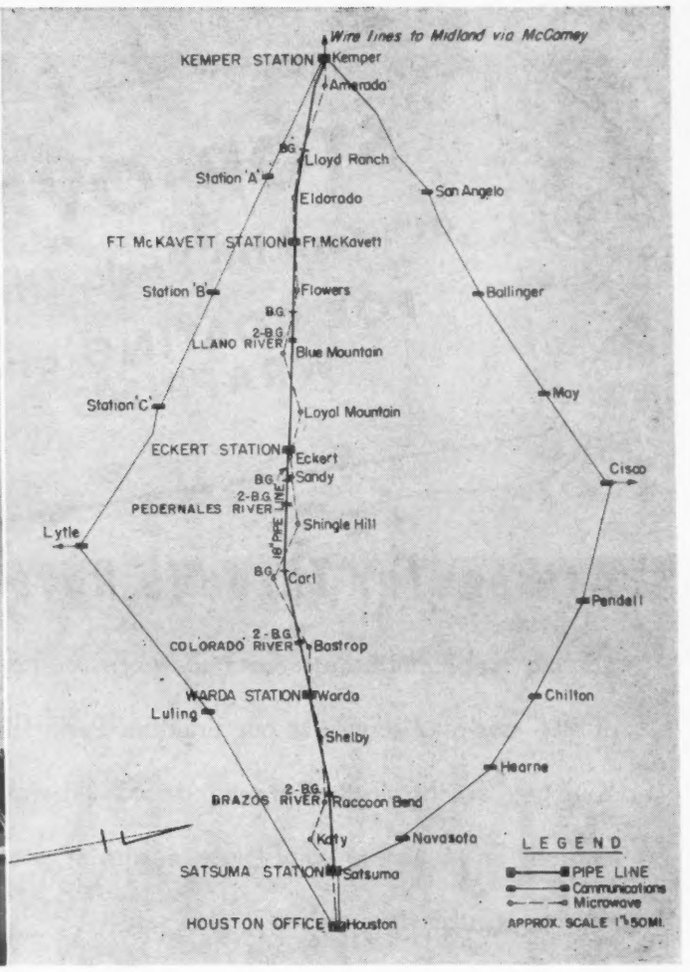


Microwave tower at Warda station.



Map of pipe line and communications systems.

Humble Uses Microwave

West Texas-Gulf Coast 18-in. pipe line is provided with an 8-voice channel system that can be increased as need arises

HEZZIE CLARK*

HUMBLE Pipe Line Company purchased a 400-mile microwave system to provide communications facilities for the operation of its new 18-in. pipe line between its Kemper station near Big Lake, Texas, and Satsuma station approximately 20 miles north of Houston, which is also a terminal of its 20-in. line to Baytown.

Selection of a microwave radio system for communications was made after a study of the rugged terrain traversed by the new line and means for providing a reliable supplement to existing wire line facilities between West Texas and Houston. Humble already has wire circuits that provide loop service between the two points, one system extending from Houston through San Antonio to Lytle pump station, which is a communications hub, thence through the hill country to Kemper station, and another system from Houston via Hearne, Pendell, and Cisco, another communications center, thence through Ballinger and San Angelo to Kemper station.

During some winters when icing conditions are bad, Humble has found that its West Texas operations became isolated due to the extent of damage to all wire facilities in the West Texas area, including those of commercial companies and other oil companies. The microwave system will prevent such isolation to Kemper station, which is a key station in pumping operations.

The system consists of 17 unattended microwave radio repeater stations in addition to the terminals at Houston and Kemper station, and at the outset provides 8 voice channels, 2 of which will drop off at the Katy Plant, 4 through or point to point voice circuits between the 2 terminals, and 2 circuits that will loop into each intermediate pumping station, one of which will be used as a high class party line talking circuit between the

*Electrical Engineer, Humble Pipe Line Company.

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stations at Fort McKavett, Eckert, and Warda, and the other is provided for future use such as remote metering, supervisory control, and teletypewriter service.

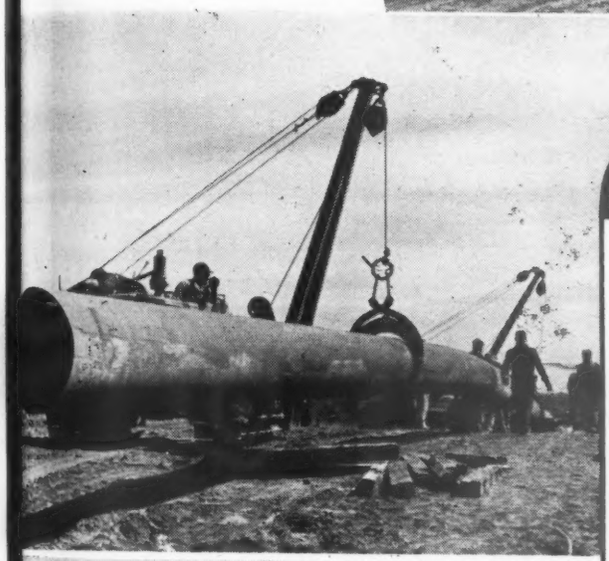
The ruggedness of the terrain and great difference in elevation between Kemper station and Satsuma station required that block gate valves be installed at certain strategic points along the pipe line, some of which are in extremely remote locations with regard to the intermediate pump stations. Consideration will be given to the practicability of remotely operating these block gate valves in emergencies, such as pipe line leaks or breaks.

Advantage was taken of high points, such as hills, along the route in order to reduce the number of towers required and to keep the height of the towers to a minimum. The system operates at slightly below 7000 megacycles (7 billion cycles per second) and transmits approximately ¾-watt power, which is ample to provide a dependable signal at all times under varying weather conditions. Antennas are not mounted on the towers as is generally done where lower frequencies are used but instead is beamed from a parabolic type reflector mounted in an equipment house at the base of the mast through a special type sky light in the roof to a passive reflector at the top of the tower, which is nothing more than a flat rectangular piece of steel mounted at approximately a 45-deg angle. This passive reflector deflects the radio beam onto a horizontal path where it strikes another similar passive reflector and is deflected downward into another parabolic type reflector, thence through the electronic repeater apparatus where it is amplified, translated, and again reflected from another parabolic type reflector to another passive reflector on the opposite side of the tower, and the operation is continued until the signal reaches the distant terminal.

The system is extremely private inasmuch as the signals are not broadcast but instead transmitted as before outlined into a concentrated beam of only 3 deg, making it possible to have other systems in the near vicinity without causing interference one to the other. Also, the signals themselves for the various channels are of what is known as a time division pulse type multiplexing system.

Many additional channels may be added at a very nominal cost when the need arises, and it is believed that the system will not be more expensive to maintain than would a wire line and will be considerably more dependable. * * *

Photos shown here were made during recent laying of a 26-inch natural gas pipe line by Trojan Construction Company.



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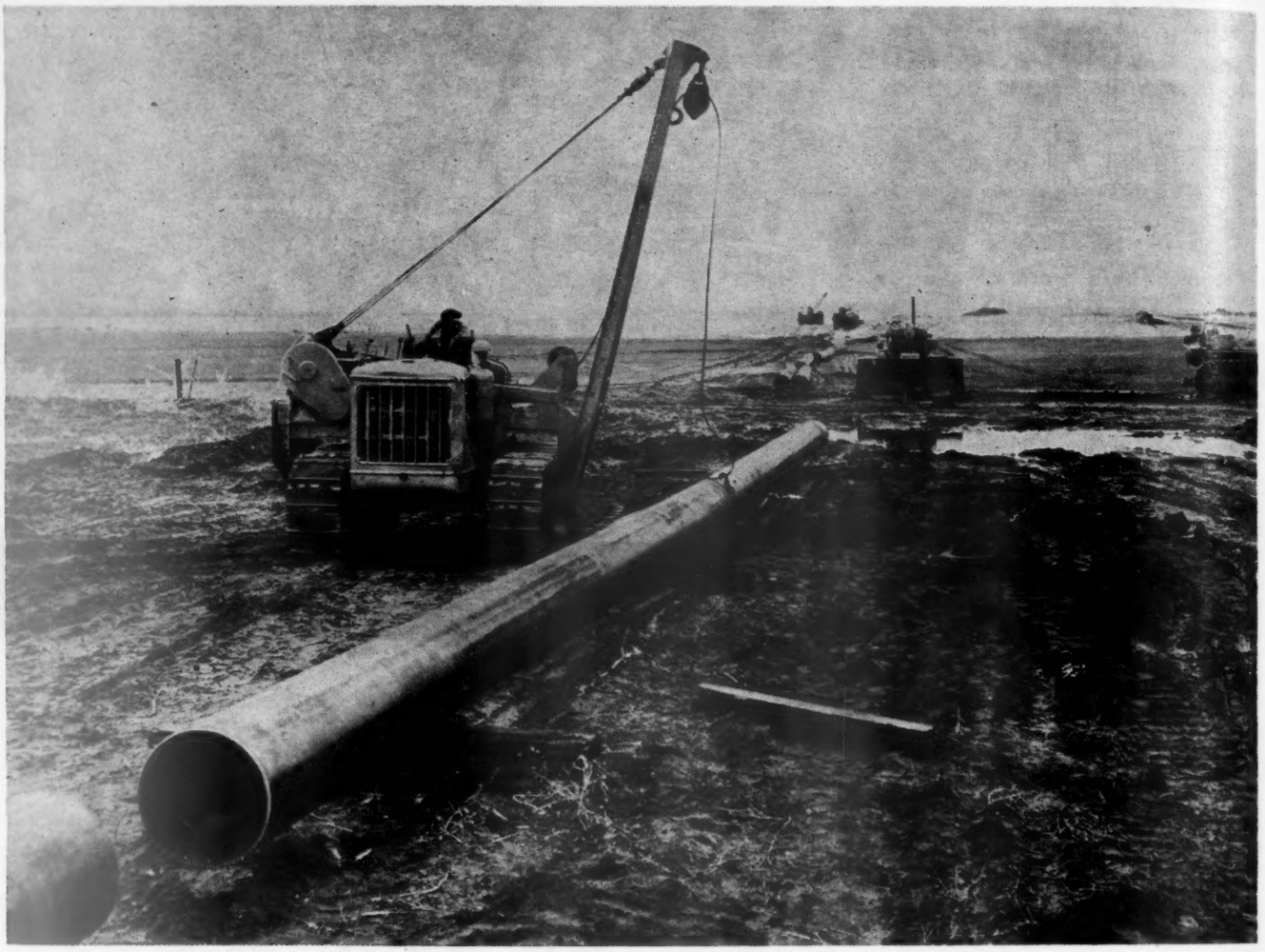

FIG. 1. Drop test with supports situated 10 ft from each end of the welded section.

WELDING HIGH YIELD PIPE

Use of high tensile strength steel in line pipe is important economic factor. Here are results of welding thin walled pipe

CARL J. COULTER

THE demand for natural gas as a domestic and commercial fuel in metropolitan areas has increased immensely in the last decade. As, in most cases, the markets are at great distances from the source of supply, the natural gas industry has been confronted with the problem of designing and constructing high pressure, large diameter pipe lines for the economical transportation of gas to those markets. The pipe lines must be so constructed as to guarantee a minimum of failures in service.

Although it is of primary importance to assure good service, construction costs also must be considered. One of the leading factors in keeping material costs, such as the cost of steel, on an economical basis has been the development and use of high tensile strength steel in the fabrication of pipe. The use of high tensile steel substantially reduces the weight of the finished product. Thus, 26-in. pipe made of steel with a minimum yield of 52,000 psi reflects a saving of 23 per cent in weight as compared to pipe made of steel with a minimum yield of 40,000 psi. Other savings effected by the use of thin wall high yield pipe are lower shipping and handling costs. Less heavy equipment and fewer men are required while laying light wall pipe.

EXCLUSIVE

The remainder of this discussion is based upon studies, experiments, and tests made by Cities Service Gas Company in 1948 and 1949 in connection with the design and construction of 370 miles of 26-in. gas pipe line extending from a field compressor station in Grant County, Kansas, to a point near Kansas City, Kansas. This line was constructed of 26-in. OD by 0.312-in. wall pipe and operates at

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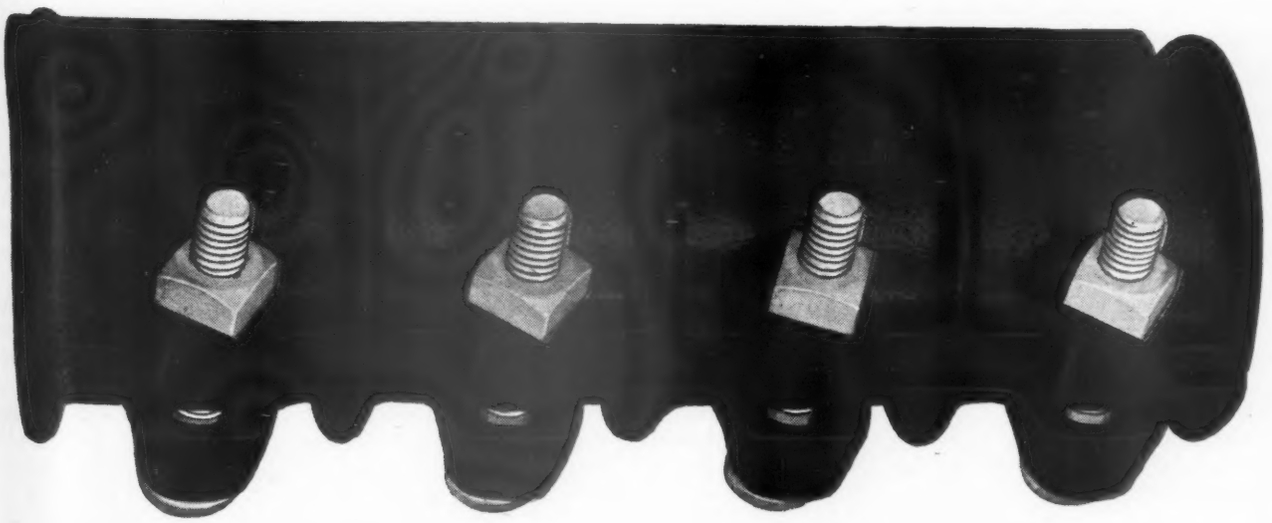

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FIG. 2. Results of drop test with support near center of welded section.

a maximum pressure of 900 psi.

The physical and chemical properties of the steel pipe being discussed in this article are given in the following table:

	Specifications	*Actual Range*
Yield strength	52,000	52,200 to 62,700
Ultimate strength	72,000	76,060 to 88,740
Per cent elongation in 2 in.	22	28 to 40
Carbon	0.20-0.30	0.24 to 0.31
Manganese	0.85-1.25	1.01 to 1.21
Phosphorous	Not over 0.045	0.010 to 0.039
Sulfur	Not over 0.050	0.026 to 0.031

This pipe was manufactured from plates of open hearth steel by rolling them into tubular blanks and flash welding the longitudinal seam to produce a pipe slightly under the desired diameter. The pipe was then subjected to internal hydraulic pressure sufficient to expand it to the required outside diameter, which materially increased the minimum yield strength due to the cold working of the steel. The ends of the pipe were beveled for welding at an angle of 30 deg to the vertical with an average width of flat at each end of $\frac{1}{16}$ in. to $\frac{1}{32}$ in.

In order to manufacture steel pipe to withstand high pressure it is necessary to increase the manganese content of the steel. Manganese is primarily a cleansing agent and tends to desulfurize and deoxidize the steel. Small amounts of manganese add to the tensile strength of the steel and give it better rolling and forging properties, but above a content of 1 per cent the manganese begins to produce hardness and brittleness. This, in turn, makes field welding of the joints a more difficult operation. To produce the most satisfactory weld, which often must be made under adverse conditions in the field, the best possible welding procedure and electrode combination must be selected, giving consideration also to speed and economy.

The desired characteristics of the finished weld are strength, ductility, and 100 per cent fusion and penetration. The physical properties of the completed weld should be similar to those of the parent metal.

Prior to, and during, the first part of the construction of the Hugoton to Kansas City 26-in. line, a thorough welding study was conducted, including exhaustive tests under actual field conditions.

Qualified pipe line welders were employed in making the test welds. The coupons were prepared in a company-owned machine shop and tested in accordance with the ASA B31.1-1942 Pressure Piping Code. The actual testing of the specimens was done in the laboratory at the Research Foundation of the University of Wichita, Wichita, Kansas.

All welds were made with four beads. The root bead was not allowed to be any thicker than two-thirds the thickness of the wall of the pipe. Type E 6010 and E 7010 and E 10010 electrodes, or combinations of these types, were tested. Some of the welds were made after the ends of the pipe had been heated to approximately 150 F to determine the effect of preheating on the finished weld. The tests showed that preheating increased the tensile strength of the weld about 4 per cent but made no appreciable difference in the root bend and face bend tests.

A high percentage of the coupons tested passed the tensile tests and free bend tests, but some of the rod combinations did not show up well under the root bend and face bend tests.

The tests of the welds made using E 7010 rod for the stringer bead and E 6010 for the three successive beads indicated this combination of electrodes was superior to the other combinations for the purpose.

A unique test that helped to influence the selection of this electrode combination was performed on a preheated weld made with E 7010 on the stringer bead and E 6010 on the other three beads. Two joints of pipe, each 40 ft in length, were welded together. This welded section of pipe was then supported with skids 10 ft from each end. A drop test was made by lifting the pipe with a boom tractor to a height of 12 ft and dropping it onto the skids; both ends of the pipe struck the skids simultaneously. (See Fig. 1.) No damage was done to the weld; however, the pipe buckled at the points of impact with the skids.

On the second drop test the skids were placed in the center of the welded section under the weld. The pipe was dropped a distance of 12 ft; it was mashed, as shown in Fig. 2, decreasing the diameter of the cross-section approximately 3 in. where the pipe adjacent to the weld struck the skids, but the weld did not fail.

The writer is of the opinion these drop tests were severe, and in all probability an inferior weld would have broken.

After an analysis of the results of all tests conducted using various rod combinations, it was decided to use the E 7010 and E 6010 rod combination and apply the second bead, or hot pass, immediately after the completion of the stringer bead, while the pipe ends were still hot, in order to relieve any internal stresses set up in the weld. By applying the second bead immediately the heat from the stringer bead created a preheating effect for the second bead. Also it was decided to preheat the ends of the pipe before applying the stringer bead when the atmospheric temperature was below 60 F.

While welding the Hugoton to Kansas City 26-in. line the conclusions drawn from the results of the tests were closely followed.

The welding inspectors were instructed to require thorough cleaning of the ends of the pipe before the welding operation was begun in order to remove all rust, scale, or other foreign matter that might affect the quality of the weld. Also, that each bead be thoroughly cleaned of all scale and impurities before the next pass was made; if not properly removed these caused slag inclusions that materially reduced the strength of the weld.

Internal line-up clamps were used to align the joints throughout the construction of the line. This eliminated tack welding and allowed the application of the stringer bead in a more uniform operation. The internal line-up clamp was not released until the stringer bead had been applied the full circumference of the joint.

* * *

The Author

Carl J. Coulter was graduated from Kansas State College in 1940. After spending a year with the Cities Service Oil Company as a junior engineer, he joined the Cities Service Gas Company as office engineer. He was division pipe line foreman and division pipe line superintendent before assuming his present position as assistant superintendent of the pipe line department.

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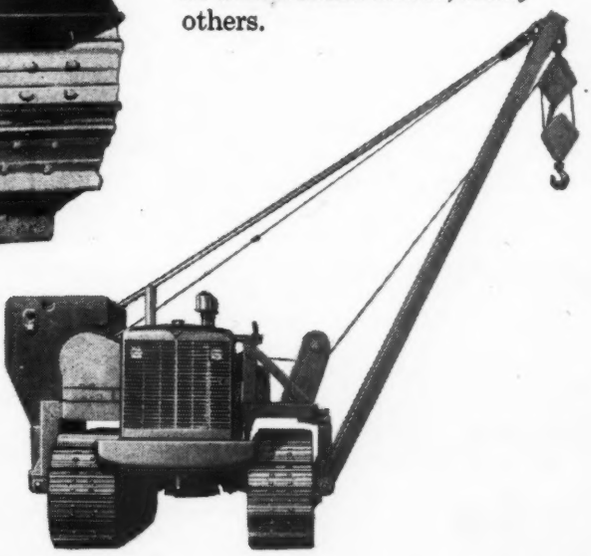

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P 615.3

Airview of some of the rugged, mountainous terrain traversed by Richfield's Cuyama to Los Angeles pipe line.

Cuyama to Los Angeles Line Now in Operation

Richfield Oil Corporation's pipe line project is an important part of a highly important development

RICHARD SNEDDON*

WHEN Richfield Oil Corporation first began producing oil in the Cuyama Valley, California, it quickly became evident that this was no minor development and that plans must be made without delay for the transportation of a sizable quantity of crude oil from the new field to the company's nearest refinery at Watson, about 150 miles to the southeast. For a short time in the beginning, curtailed oil production from the first Russell Ranch well was trucked to Taft. Then a 6-in. line was laid on top of the ground to Lake station on the San Joaquin Valley-to-Los Angeles trunk. This was built of lightweight war surplus pipe and, of course, was just an expedient designed to provide temporary relief while arrangements for a permanent system were made.

The initial permanent step was the construction of an 8⅝-in. line to Lake station, which is about 30 miles east of the Cuyama field. The total plan, however, involved the construction of a continuous line, striking southeast with a 10-in. spread from the field to Wheeler Ridge, thence paralleling the existing line through Tejon to Newhall with a 14-in. line, and finally through Los Angeles to the refinery at Watson, just north of Wilmington, with another 14-in. spread that tacked to the east of the existing line, presumably to skip congested city areas so far as possible.

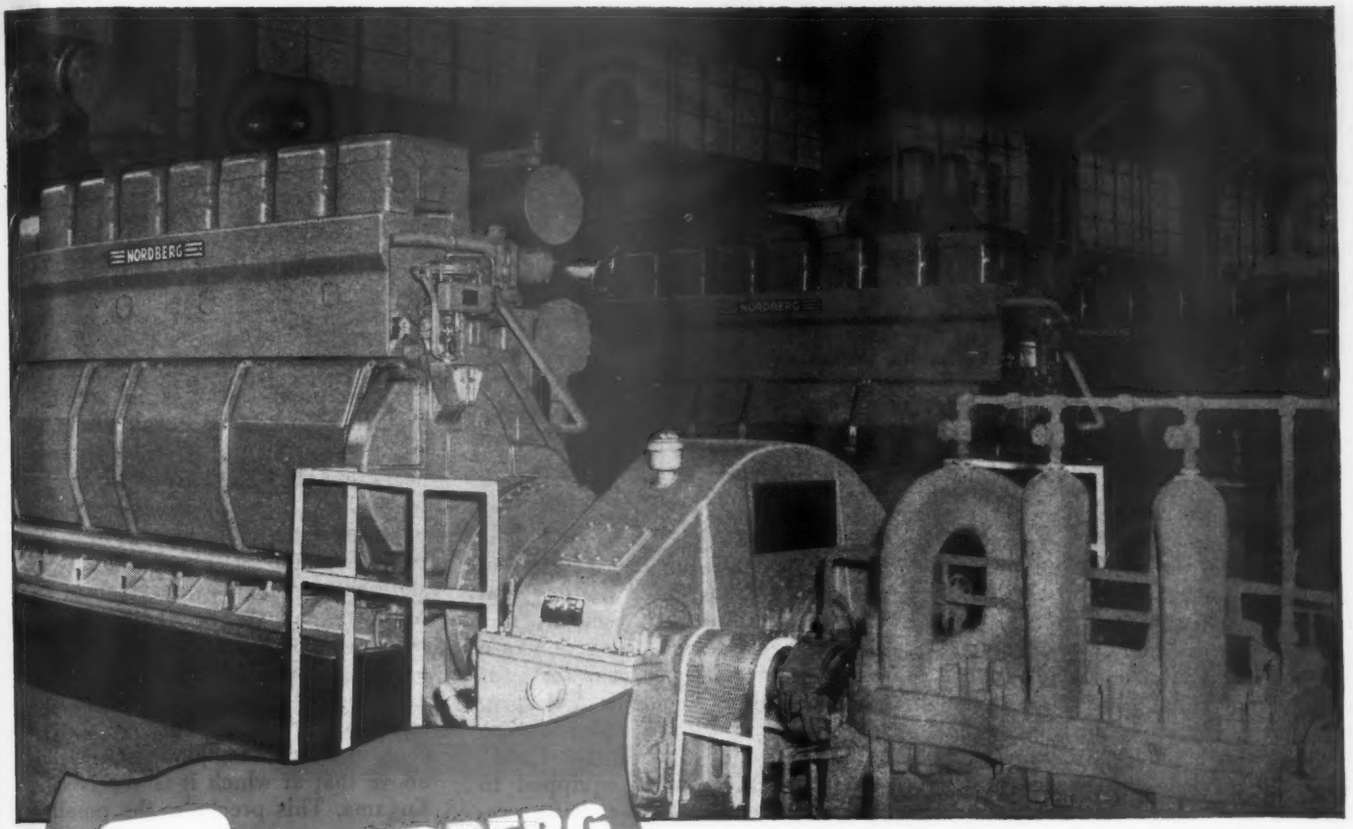
EXCLUSIVE

The Cuyama to Wheeler section was finished in March, 1950, and was so designed that by the addition of an intermediate pumping station its capacity could be increased from its present 51,000 bbl a day to 73,000 bbl. Work on the initial 58 miles of the 14-in. section, from the refinery to Newhall, was completed about the same time, and the final link over the mountains from Wheeler to Newhall was just finished in February of this year. Total length of the main line from Wheeler to Watson is 112 miles, which with the laterals to the field from Wheeler and Lake stations adds about 180 miles to the Richfield total of field gathering and trunk lines, now well over 700 miles.

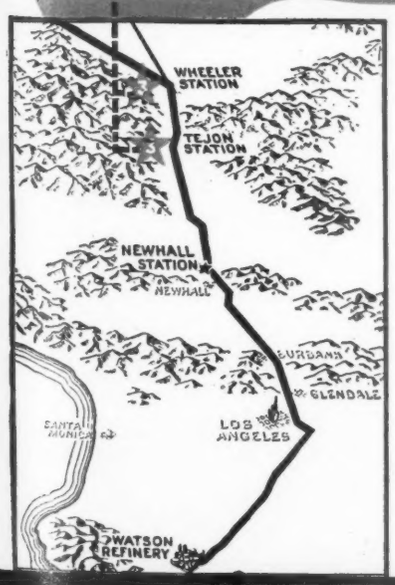
The old 10-in. line, stretching from Buena Vista Lake, seven miles east of Taft, to Los Angeles, was built in 1925 and was quite inadequate for transporting the mounting output of the Cuyama fields together with other established San Joaquin Valley commitments. Its capacity was roughly 30,000 bbl a day, and as the production of Cuyama is currently somewhere between 50,000 and 60,000 bbl a day, the need for enlarged facilities becomes obvious. The new 10-in. line from Cuyama to Wheeler has a carrying capacity of over 50,000 bbl a day, and the 8⅝-in. line to Lake station is capable of transporting about 30,000 bbl a day, so there is sufficient gathering and trunk line capacity to take care of the field for some time to come.

The main line pipe, consisting mostly of 14-in. OD electric weld or seamless, was used in varying thicknesses from ¼ to ⅜-in., depending on anticipated pressures, which vary over the changing elevations, ranging from practically sea level to more than 4000 ft. By the installation of a 14-mile stretch of 16-in. OD line, varying similarly in wall thickness from $\frac{9}{32}$ in. to ⅜ in., design engineers were able to reduce line pressures enough to eliminate one pump station. All pipe was protected against corrosion with a heavy asphaltmastic coating, applied in the factory to within 9 in. of the ends. Careful check of this coat was made for holidays by the usual type of holiday detector and further tests

*Pacific Coast Editor



6 NORDBERG *Duafuel** ENGINES supply 6300 horsepower for new RICHFIELD PIPE LINE



ILLUSTRATED here are three of six Nordberg Duafuel* Engines installed in the Tejon and Wheeler Ridge pump stations of the new Richfield Oil Corporation 14-in. pipe line, which connects the company's production in the San Joaquin and Cuyama Valley fields with the Los Angeles area. These dependable 7-cylinder Supercharged Nordberg Duafuel* engines each develop 1050 hp at 450 rpm, and are designed to operate on natural gas plus Cuyama Crude as pilot oil, on straight Cuyama Crude, or with any proportion of either fuel. Instantaneous conversion from one fuel to another allows the most economical fuel to be used at all times.

For main line or booster stations—wherever you must keep petroleum products on the move with plenty of power—you can count on Nordberg engines to do a dependable, economical job, day-in, day-out. Built in a wide range of sizes up to 9600 hp, including 2 and 4-cycle types, and Diesel, Natural Gas and Duafuel* models. (**Trade Mark*)

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Richfield Oil Corporation Officials

were made in the field after the bare sections in the vicinity of the welds had been coated.

After the pipe had been strung and welded, these bare sections were cleaned and primed with a binder material in preparation for the completion of the asphaltmastic covering. When the primer was dry, a steel form was clamped over the coated pipe, with center leaves opening over the uncovered sections. Into this form the hot asphaltmastic was poured from a portable heating unit and was then tamped down around and under the pipe. Adjustable leaves of the form were then drawn together, compressing the mastic material against the primed pipe in such a manner that it overlapped the coated middle sections. Thus, when the forms were removed, there remained a seamless and completely uninterrupted coat of considerable thickness. The protective composition was applied to special fittings and bends by hand troweling.

Further safeguard against corrosion was provided in the form of permanently installed clips to which connection may be made at any time in the future for the determination of soil potential and what, if any, cathodic protection may then be required. These clips were placed at strategic intervals along the line and particularly at those locations where conditions might be conducive to electrolysis. Other precautionary measures include the installation of sectionalizing valves at all vulnerable crossings and the adequate insulation of the flanges on such valves as well as valve flanges on lines leading to or from the pump stations. Welded joints were, of course, X-ray inspected and it is interesting to note that not a single failure of a contract weld was reported.

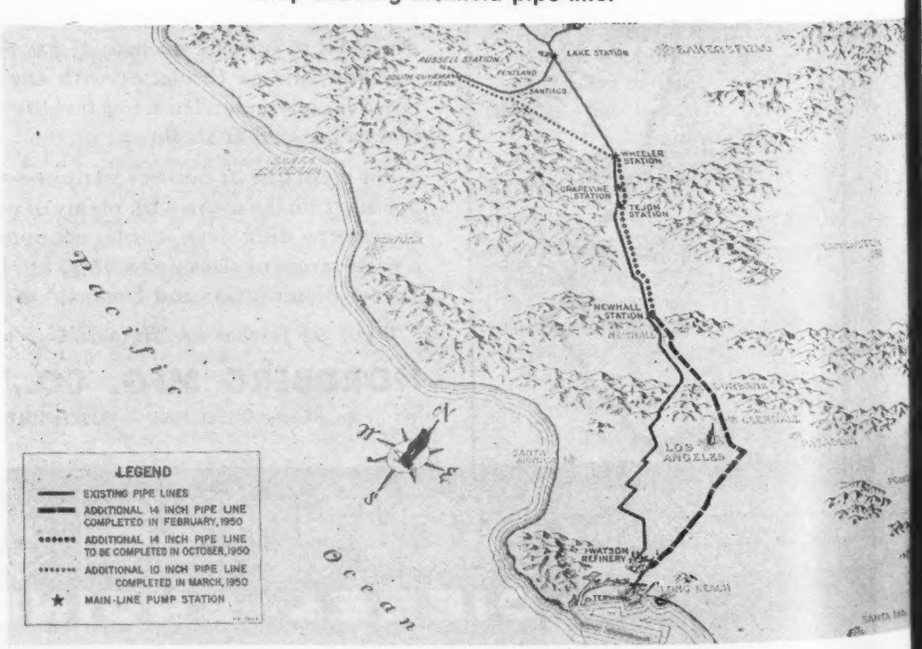
The line, particularly that section from Wheeler to Newhall, traverses some wild mountainous terrain but apparently it presented nothing that was insurmountably difficult. The steepest grade encountered was a short piece of 35 per cent that was handled without incident. A suspension bridge, 300 ft from pier to pier, had to be built over Alamos Creek, near Caswell. This is equipped to carry another line when and if necessary, and whereas it introduces nothing of a revolutionary nature, it involves the application of some quite profound engineering principles as may be seen from the accompanying illustration. It was designed by Richfield engineers and checked by the cable suppliers.

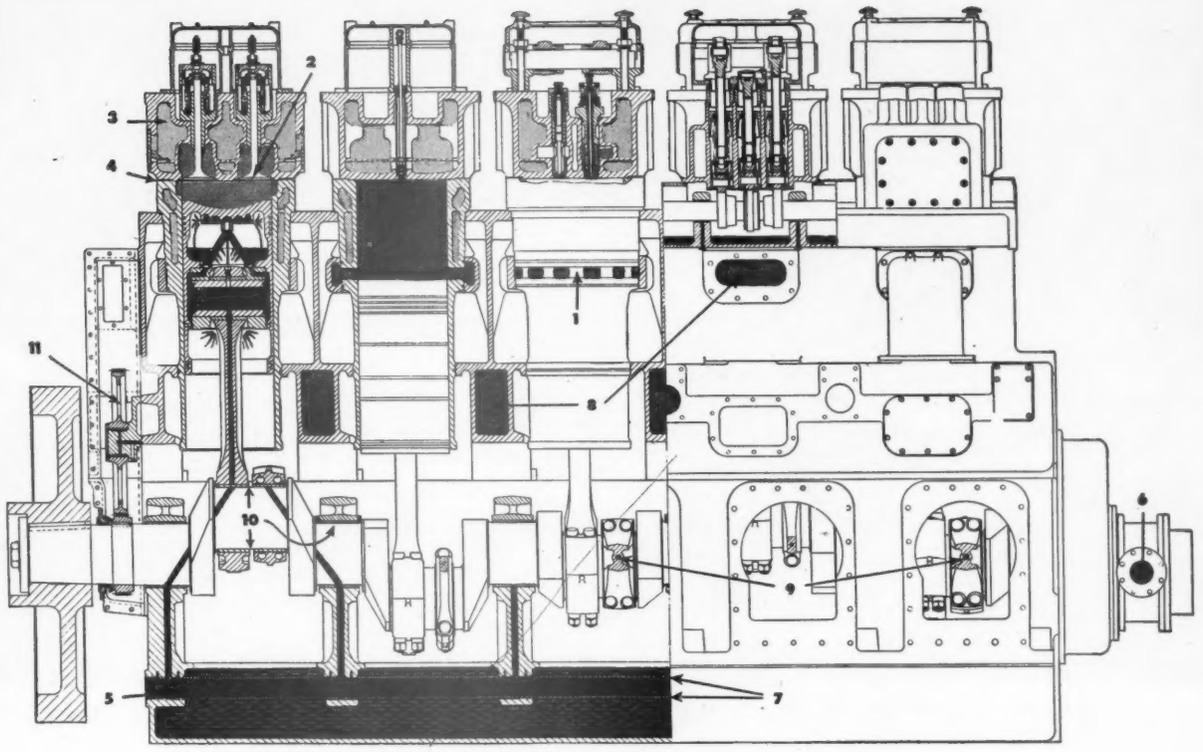
The use of long radius bends was resorted to so far as possible in order to increase hydraulic efficiency and to facilitate the passage of scrapers through the line. The fact that there was no interruption in the initial scraper test shows the care that was exercised in laying the pipe, and further indicates that the system is all clear. Scraper traps were placed at appropriate points and practically the entire line can now be subjected to scraping in easily negotiable increments.

The design of the line and the pump stations was based on the lowest recorded temperature, 44F, and an average crude gravity of 35 deg API. Plans called for the construction of two new pump stations, one at Wheeler Ridge and one at Tejon. It should be very satisfying to the design engineers that the effects projected mathematically are being actually closely obtained in actual practice. For example, the heaters at Wheeler and Tejon stations raise the temperature of the oil just about 10 F. By the time it reaches Tejon it has cooled off 7 F and going through the heaters there is again boosted 10 F. Over the remaining distance from Tejon to Watson it cools again to a temperature just 2 F above that at which it is received in Cuyama. This precludes the possibility of any consequential evaporation loss and coincidentally confirms the calculations and deductions of the design engineers.

The two new pump stations are each equipped with three turbo-supercharged, 4-cycle, dual-fuel diesel engines one of which in each case will be used as a standby. These are rated at 1050 hp at sea level, or 987 hp at 3075 ft, which is the elevation of the Tejon station. The engines are 7-cylinder, 13-in. bore, 16½-in. stroke, and

Map showing Richfield pipe line.





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11 Gear driven camshaft. Positive, quiet operation.

fits for smoother operation. It is the first time this type of scavenging has been adapted to engine compressor duty and its incorporation with the advanced over-all UTC-16 design marks the beginning of a new era in lower-cost, more dependable performance.

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The uniflo UTC-16 is built in sizes ranging from 800 to 2,000 hp. If you have a process where gas must be compressed, and a suitable gas fuel is available, make a point of investigating this outstanding angle gas engine compressor. For further proof that *there's more worth in Worthington*, contact our nearest Branch Office, or write the *Worthington Pump and Machinery Corporation, Engine Sales Div., Buffalo, N. Y.*

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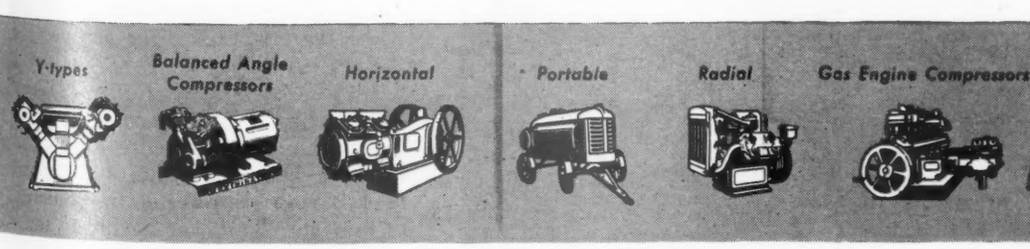

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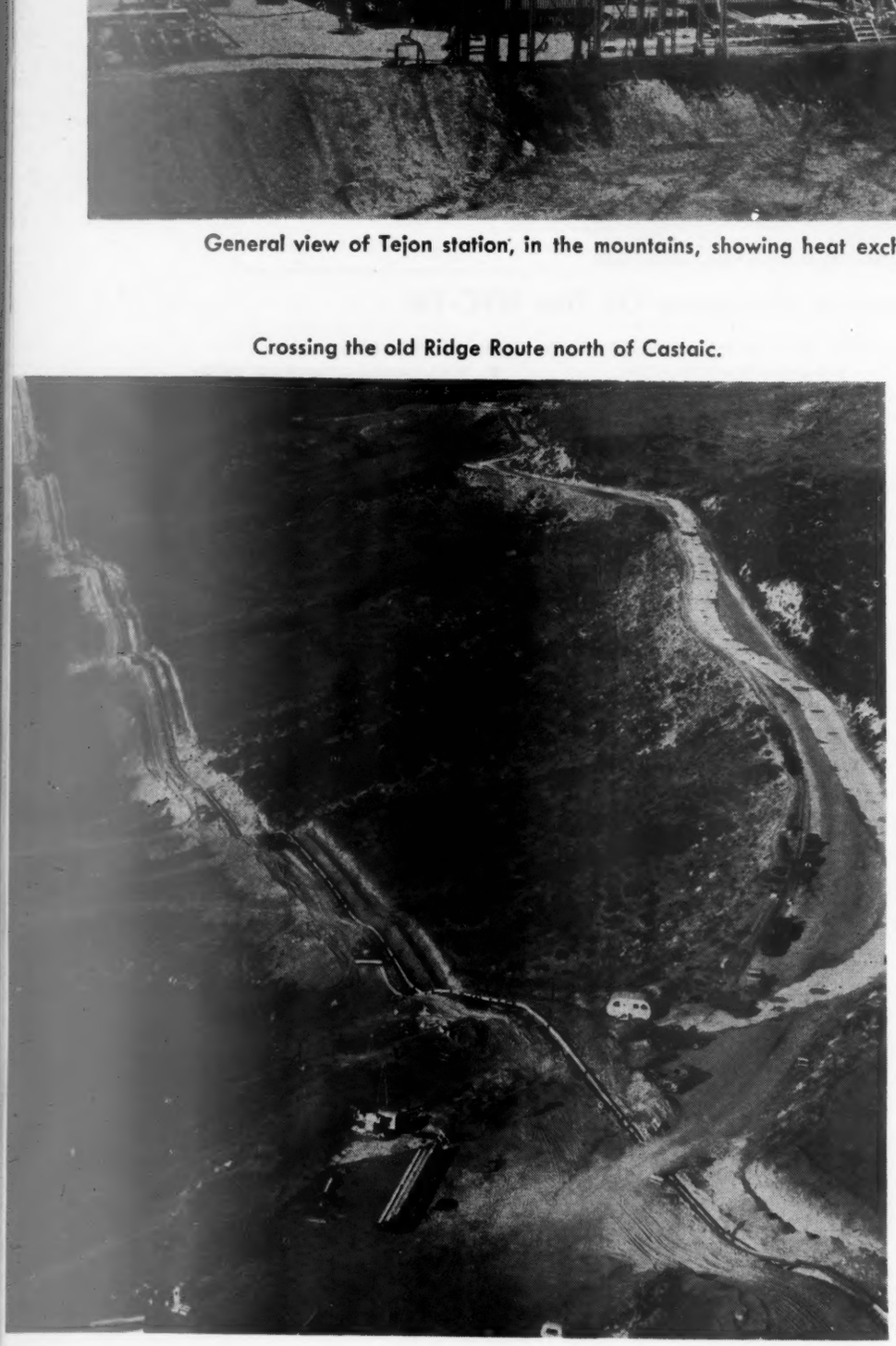
General view of Tejon station, in the mountains, showing heat exchangers and engine silencers.

Crossing the old Ridge Route north of Castaic.



operate at 450 rpm. Each engine drives a 6-in. by 8-in., 6-stage, horizontal, split-case, pipe line pump, through an 8 to 1 speed increaser that steps the rpm up from 450 to approximately 3600. The pitch line velocity of the gears in these increasers is 6100 ft per min. They are pressure feed lubricated and water cooled. The pumps have a rated capacity of 40,000 bbl a day against 1000 psi when pumping crude of 30-deg API gravity.

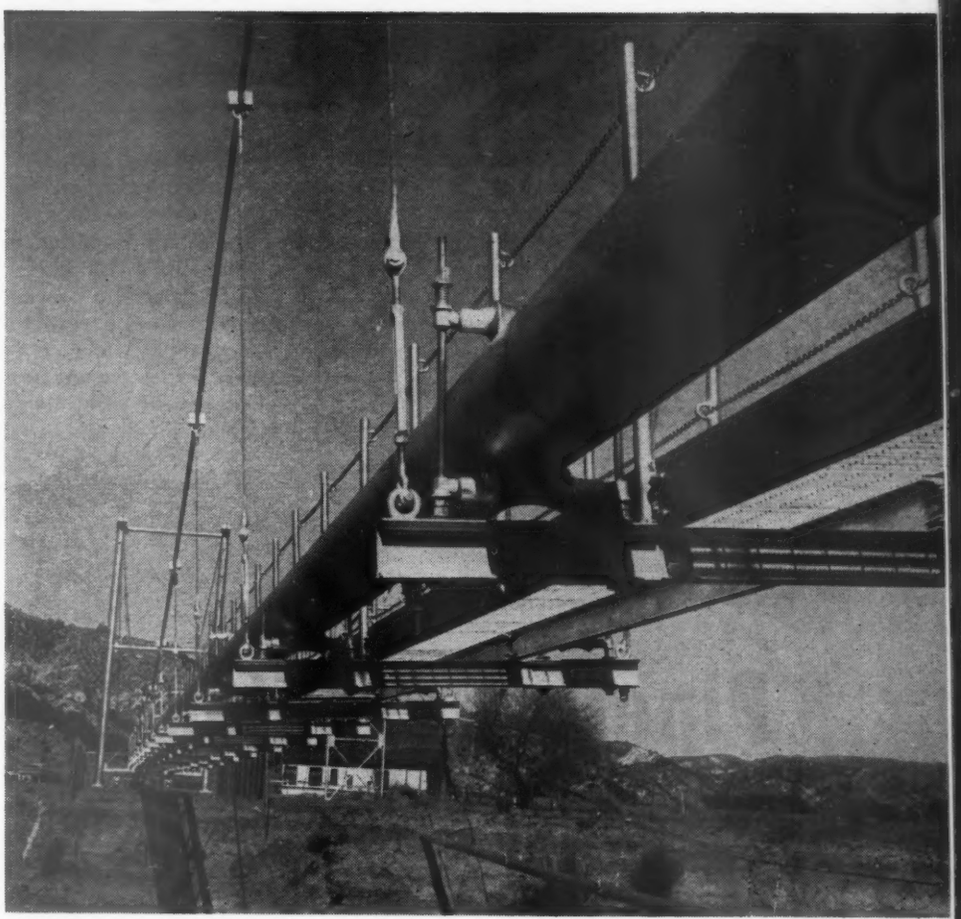
The dual-fuel engines now operate on Cuyama crude, which is preheated by means of a fuel oil heater, using jacket water as the heating medium. As future crudes might have a higher sulfur content than is ordinarily permitted in a diesel fuel, the injection pumps and nozzles are made of corrosion-resistant material, and the latter are further protected by a liquid cooling system. Although the engines have been operated initially, however, on Cuyama crude, gas will be available in the off-peak demand season and will become the principal fuel, with the crude then being used as pilot oil. The engines are designed to operate on any proportion of gas and oil and automatically change from gas to oil when for any reason the gas supply is interrupted.

Engine accessory and auxiliary equipment includes variable-speed hydraulic governors to control the function over a speed range from 383 to 472 rpm; pyrometer instruments to indicate significant operating tem-

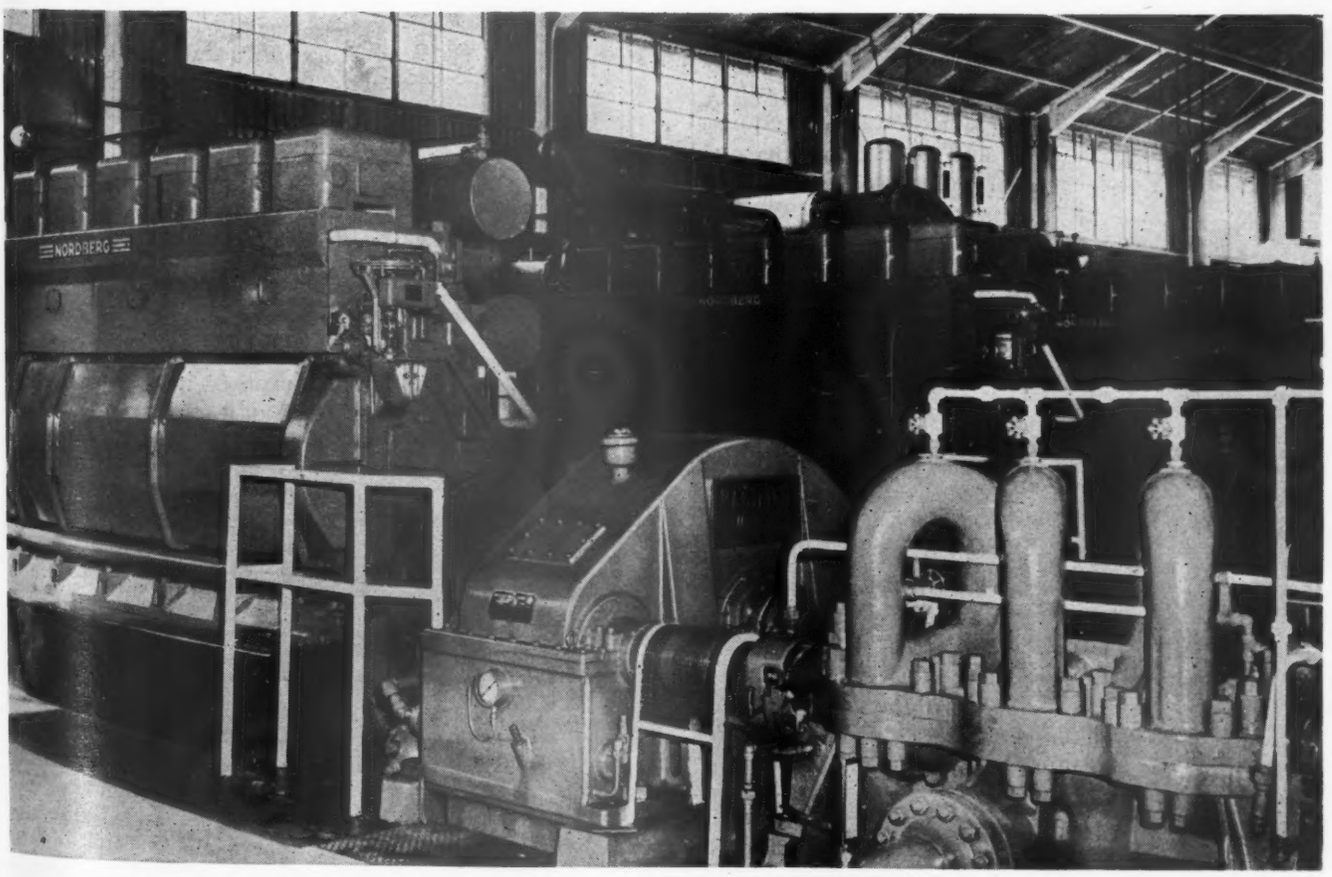
peratures; electric tachometers to record engine and pump speeds, and an alarm system to disclose high jacket water and low engine lubricant pressures. Engine jacket water and lubricating oil for the speed increasers are cooled by devices that employ crude oil as the cooling medium, an arrangement that renders raw water cooling equipment unnecessary. The air intake is provided with silencers and bath filters, and lubricating oil filters incorporate a means of preheating. A small compressor injects starting air and centrifugal pumps keep the jacket water in circulation. All engine exhaust silencers are equipped with relief covers.

Additional new equipment at the pump stations includes a 54,000-bbl tank at Wheeler where there were already two 37,500-bbl containers in service. This was considered sufficient new capacity to provide relief for the increasing Cuyama production. Existing storage at Tejon also consisted of two 37,500-bbl tanks and no further installation was deemed necessary there.

Before the stations were built, a complete soil analysis was made in order to determine safe bearing stresses for the building and machine foundations, and sites were carefully chosen to blend the right combination of stability and general convenience.



Suspension bridge over the Alamos Creek, designed by Richfield engineers and checked by the cable suppliers.



Dual-fuel diesel engines drive horizontal, split-case pumps through 8 to 1 speed increasers.

To obviate the possibility of danger from excessive line pressures, safety valves were installed at Vinvale refinery, Newhall station, and Watson refinery. In the meantime, during the preliminary period of operation, many sections of the line will be walked in the old fashioned way as an extra-precautionary measure, but when settled weather prevails and indications are that the entire project has passed its probationary term with honors, the engineers will relax and line "walking" will be done at an altitude of several hundred feet by airplane.

It would appear from all accounts that the new Richfield line from the Valley to Watson refinery was probably one of the smoothest pipe line jobs that has ever been accomplished in any part of the country. Every phase of the job was worked out with meticulous exactitude by company engineers and those representing the contractors and suppliers and there was scarcely a hitch in the proceedings. All contractors and purveyors of equipment were people widely experienced in their respective arts and the job perked along with rare smoothness from start to finish and in its every aspect. The total cost was in the neighborhood of $7,000,000 and with its completion, Richfield now has two parallel lines with a great enough combined capacity to permit unrestricted development of its San Joaquin Valley interests for some time to come.

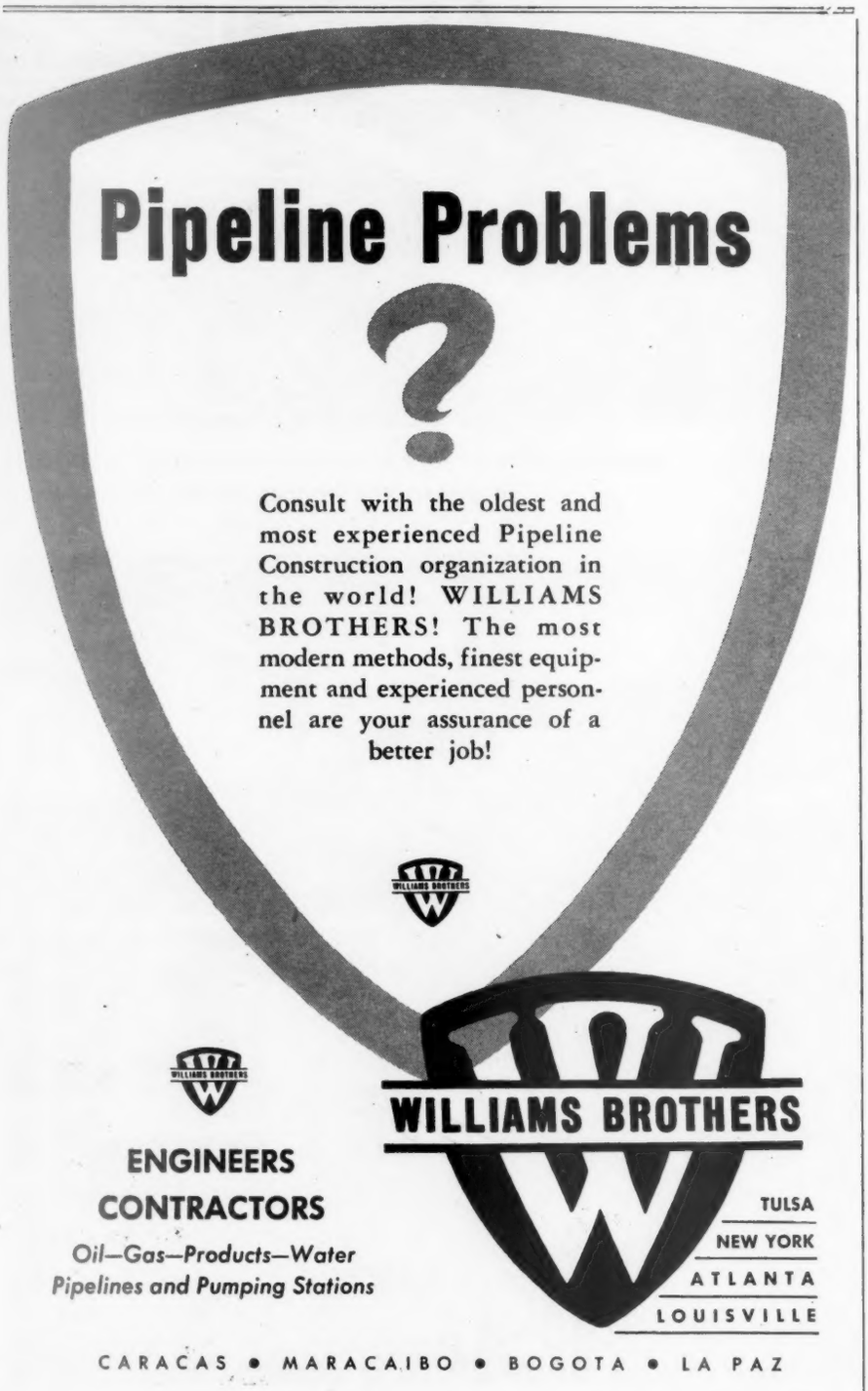
Executive direction of the project for Richfield Oil Corporation was vested in David E. Day, vice president in charge of manufacturing and pipe lines. Responsibility for the design of the stations and laying of the lines fell to Norman F. Anderson, pipe line manager, and Donald F. Purdy, chief engineer of the pipe line department, both of whom are men of long experience in pipe line construction, operation, and maintenance. They were ably represented in the field by John F. Lynch, project engineer.

Engineers Limited Pipeline Company constructed that part of the line between Wheeler and Newhall, and J. E. Young Pipeline Contractor, Inc., and Alex Robertson Company the section from Newhall to Watson. Station construction was by Refinery Maintenance Corporation.

The completed project is believed to be one of the most modern in the country. The use of pipe thicknesses adapted to projected line pressures resulted in a considerable saving of steel at a time when such a saving was of vital importance. The new stations feature the most advanced power engines, pumps, and auxiliary equipment of their type, and instrumentation for control and recording of pressures, temperatures, fuel consumption, pumping rates, and other essentials, represents the latest in measurement engineering.

The project was not a large one as such projects go, 112 miles of line and two new pump stations, but it is definitely an important part of a highly important development. Cuyama is now more than the mere site of an oil discovery. Since June, 1948, when the field first came in, it has expanded remarkably and around it in the meantime has grown a typical American community that already has all the appearance of permanence and stability. To that community the new Cuyama line is a convenient and economical outlet for one of its major products—oil. There is little question that, as it has done the world over, oil will bolster old established industries in the area, stimulate the birth of new industries, bring better roads on which more people will be induced to travel into the area, and enrich it in a multitude of ways. The easier and cheaper oil can be moved to market the greater are the benefits that accrue to the community in which it is produced.

* * *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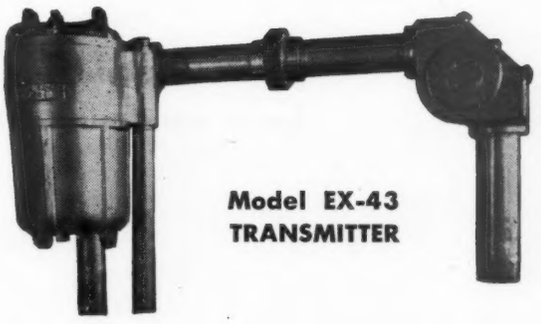

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Corrosion Program for a Pipe Line

Careful planning is necessary if program is to have maximum efficiency at minimum cost

MARSHALL E. PARKER

IN the process of planning and developing a new pipe line project, be it crude oil, products, or gas, the personnel of the new company are so burdened with pressing decisions on such a variety of matters that any portion of the planning that does not actively demand attention is quite likely to be deferred. Adequate provision for a corrosion control program is all too often placed in this deferred category. Those who are in a position to know the facts are aware that a large number of major pipe line projects, some of them completed within the last few years, have been forced to spend thousands of dollars more for satisfactory corrosion control measures than would have been required if this phase had been given sufficient emphasis in the early planning stages. The immediate future may see fewer major projects undertaken, but those that are built will be built under conditions of urgency and shortage of trained personnel. These factors will combine to make even more difficult, though by no means less important, the careful planning that alone can lead to a corrosion program of maximum efficiency at minimum cost.

Information from two sources must be combined to formulate a successful corrosion mitigation program; first, the available body of knowledge (which is constantly expanding) concerning the general field of corrosion control; and second, the specific data describing the pipe line under consideration, its characteristics and the environment in which it lies. In some cases, the knowledge in both of these categories may be in the possession of one man; that is, the company may have a good corrosion engineer who is thoroughly familiar with its lines. In other circumstances, there may be required a meeting of minds in order to develop and execute a program; a corrosion engineer in private practice may supply the expert knowledge while company personnel supplies the necessary familiarity with local conditions.

The Author

Marshall E. Parker is a consulting engineer in Houston, Texas. His activities are confined largely to the field of cathodic protection and include corrosion surveys, reports, and inspections. He was recently associated with Cathodic Protection Service, Houston, in which capacity he installed some 50,000 lb of magnesium anodes. Prior to that he was with Pan American Pipe Line Company, and has been a relay engineer, geodetic cartographer, and a teacher of mathematics, surveying, and aerial photogrammetry. He holds a BS degree from Sam Houston College, a BA from Rice Institute, and is a registered professional engineer in Texas.

When the line under consideration is a new project, there is no one who knows the line and its route. When, in addition, the company itself is a new organization, as is frequently the case these days, there is no corrosion engineer. With both of these sources of information and knowledge absent, there is no program. The prime opportunity to establish a sound and profitable corrosion program exists while the planning and construction is under way; every step in the program that is deferred will prove to be more expensive when it is finally taken.

Another factor that has been taken into account in outlining the program here presented is the fact that a large part of the work normally done by the corrosion engineer is below the professional level, and can be adequately performed by technicians who have had a moderate amount of training in the specific tasks to be performed. This means that the engineer's time can be devoted to the necessary supervision and planning, and extended over a much larger domain, with no loss of effectiveness; clearly a more efficient utilization of available resources.

EXCLUSIVE

Pre-construction Period

As soon as the planning has reached or approached the stage at which decisions concerning line location and other constructional details are being made, the services of an experienced corrosion engineer should be obtained. It is not necessary, nor is it always advisable, to procure the full-time services of such an engineer by employing him; it may even be difficult or impossible to do so. In the first place, although the broad experience of a competent man is needed for numerous decisions at this stage, his full time is not required; secondly, permanent company personnel can be trained in the technical duties involved, under his supervision, and at the same time be performing necessary functions.

It is customary for each of the survey parties engaged in the operation of establishing the alignment to be accompanied by a company representative, to report progress and generally supervise the work of the contract survey party. It is proposed that this representative be one of the corrosion engineer trainees, who will later assume the responsibility for the functioning of the company's corrosion control program; these men are to be technicians, operating under the supervision of the corrosion engineer. If men with an engineering education are selected, they may be expected to acquire fully professional status as a result of their training and a few years' experience.

The trainee who is assigned to this duty should be supplied with a good set of instruments. He will not find applications for many of them at this time, but they are instruments he should be getting acquainted with, for they will all be needed later. For daily use during the survey, he should have

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a lightweight soil resistivity meter. The one-rod type is entirely adequate for this service, as the purpose is simply to gather superficial data and to gain a rough idea of the soil types traversed by the line. Information should also be gathered on all pipe lines crossed. If possible, the ownership should be determined, so that the owners may be contacted for information on the existence and location of cathodic protection units on the lines —every crossing is a possible source of stray current exposure. The pipe-to-soil potentials of these lines may be determined at this time; often this will disclose the presence of cathodic protection and indicate the proximity of the units.

All power lines crossed should be located in the notes, particularly those of distribution voltage, as such crossings are ideal locations for rectifier installations, if otherwise suitable. If time is available—as it frequently will not be—some investigation should be made of possible sites for the installation of rectifier ground beds, by measuring soil resistivities at 10 to 20-ft depth, using the four-terminal type of instrumentation. In the absence of time for such thorough mapping of potential sites, a more superficial study should be made of each likely location with the simpler one-rod instrument.

Electric railway crossings, and any other possible exposure to stray direct currents, should be carefully noted — particularly any that are likely to escape detection on maps— for a more thorough investigation, which will almost certainly be required.

All data gathered should be carefully preserved. It is strongly recommended that bound field books be used for this and all later surveys, and that the entire series of such books in use throughout a company have their pages numbered in one consecutive series. This is a thoroughly tested system with many advantages, all apparently minor until something goes awry and a great deal of valuable time is lost looking for something out of place. As a given set of notes may be identified by a single number, the field notes may readily be indexed on a set of maps. Color symbols may be used to distinguish different types of surveys, such as soil resistivity, pipe-to-soil potential, line current, and others.

It might seem advantageous to let the location of the line be partly determined by the corrosive characteristics of the soils traversed, so that particularly bad spots could be avoided. Such is the effectiveness and economy of a well-designed cathodic protection system, however, that seldom can a departure from the alignment otherwise most suitable be justified economically. Often it is possible to protect a mile of line for the cost of 10 ft of the same line; it is obvious, then, that a re-alignment could not often be made at a saving.

Another phase of the pre-construction work, entirely separate from the above, concerns the design of the system and the writing of specifications. Much of this vitally affects the corrosion program — more than just the coating and wrapping specifications. The design of cased crossings is an example. Improperly designed, or, even more common, improperly installed casings may easily result in doubling the load on the cathodic protection system. The connections on the line should be examined and locations specified for the installation of insulated joints. Frequently it may be necessary or advisable to install a pair of flanges solely for the purpose of sectionalizing the line electrically; in other places, insulating material in the flanged joints of valves and other fittings may serve the purpose adequately. When this system is used, however, extreme care must be taken to avoid the inadvertant short-circuiting or bypassing of insulated joints by gage lines, metal walkways, and other metallic structures, which are likely to be overlooked. Wherever the plans call for the installation of insulating material, the contract documents should make it the responsibility of the contractor that the joint is actually insulated — not merely call for the installation of certain material. This same provision should be included for casings in which the pipe is supposed to be supported so as to be electrically separate from the casing. Admittedly, it is troublesome and expensive for the contractor to pull a joint of pipe out of a casing and reinstall it, and it holds up construction, but it is more than difficult after the line is completed—it is well nigh impossible.

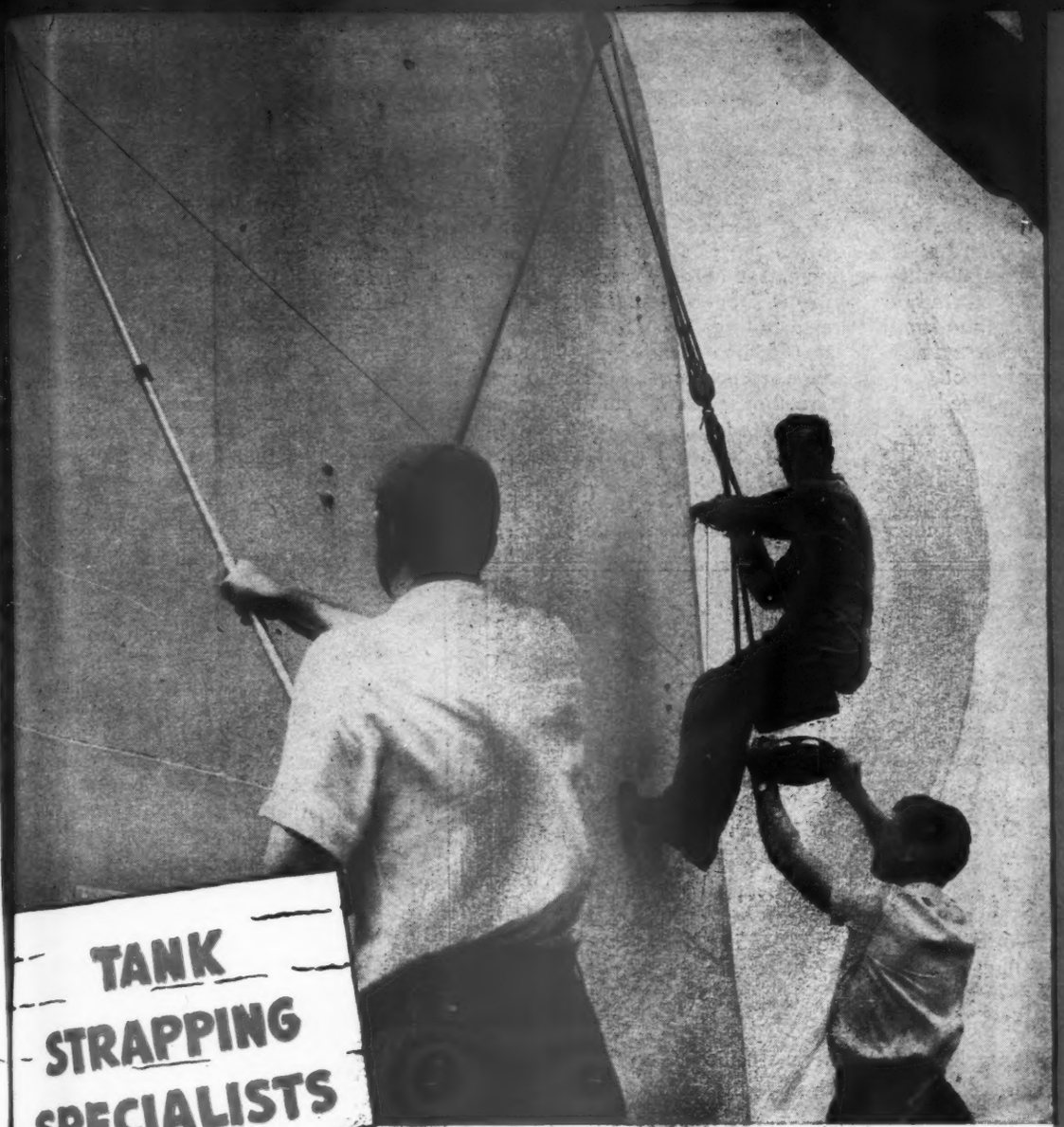
It should not be necessary to point out that the selection of the kind and amount of coating and wrapping to apply is a decision that vitally influences the overall cost of the corrosion program. If it were possible to obtain a coating job good enough to protect the pipe without the need for cathodic protection, such coating might well command a price considerably above the usual. As this is not possible, a balance must be struck between coating costs and cathodic protection costs. A fairly good coating, very carefully applied, may be 98 per cent effective. Then the most that can be profitably spent on a better coating is within the cost of complete cathodic protection of that remaining 2 per cent. Somewhere within this region is the point of minimum expenditure for complete protection—just where, is dependent upon many factors; certainly this choice should not be made by the inexperienced.

Construction Period

During the process of actual construction, numerous inspectors are required to supervise various aspects of the contractor's work. Some of these posts should be filled by the corrosion trainees. Under proper direction they will be able to discharge their inspector's duties, while at the same time advancing the company's corrosion control program, in three ways. First, a very considerable amount of corrosion data can be gathered; second, they will be receiving valuable training in corrosion work, and finally, they will be gaining that familiarity with the line and its environment that is one of the essential ingredients of a sound program.

The first of these inspector-trainees should be assigned to the ditching crew. As an inspector, his duties are not particularly arduous, but they require his presence at a part of the work that precludes his giving much attention to other phases. While the ditch is open, however, there exists an opportunity available at no other time in the history of the pipe line, to make frequent measurements of the soil resistivity at pipe depth. These readings may be taken with simple equipment—a one-rod instrument is quite adequate. They should be taken at such intervals as are necessary in order to show all the changes in resistivity; visual inspection is useful in suggesting spacings. It is suggested that a maximum spacing of 200 ft be used, even where the soil is uniform or appears to be. In this way very little doubling back will ever be necessary. The readings should be recorded in a field book, as described above. The station number should be recorded to locate all readings, and, when these notes are consulted later, it should not be forgotten that the stationing available at this time is that of the construction survey; the final maps will probably be based on a later chaining. To help avoid confusion of this sort, records should be made of fences, roads, and other indentifiable landmarks in the notes.

A position of great importance to the ultimate cost of corrosion control is that of coating inspector. The trainee who performs this vital function should do so only under close supervision, unless he has had experi-



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ence in this line. It is a serious mistake to expect one man to perform this task; he must have assistants, although they may be relatively unskilled. For he will have numerous duties and responsibilities, and must go here and there about the job quite often. Too, he needs the opportunity to raise his head and look around from time to time; he must be free from being tied down to a single spot.

Two men should be assigned the operation of the holiday detector. Perhaps this feature of the inspection will be contracted, in which case it is probable that two men will be assigned to it. These should work directly under the coating inspector, and report to him. It is his duty to interpret their findings, and to see that proper remedial measures are taken where required. He must also keep a watchful eye on the cleaning and priming, to the end that only properly primed pipe will be coated. He must watch the handling of coated pipe, to prevent damage thereto; also the application temperatures, the handling and storage of materials, and a number of other details.

Every insulated joint called for in the plans should be checked as soon as possible. This operation is much easier if at least one side of the joint is not connected to any appreciable length of pipe. Under these conditions a direct measurement across the joint will show a very high resistance, if the joint is indeed properly installed. On the other hand, a well insulated joint with several miles of buried pipe on either side will actually measure very low resistance—perhaps only a few tenths of an ohm—because of the ground connection of the long lines. Similarly, every casing installation should be checked, to be sure that the pipe is not short-circuited to the casing, unless the short-circuited design is being used. Coated casing may be swaged and welded to the line, in which case the cathodic protection of the casing is simply included with the line. This technique is quite practicable when casing can be installed in open ditches, but where they must be pushed through borings, the coating is likely to be severely damaged. Because of the fact that even the best and most carefully made installations frequently short-circuit, it is considered better to coat and wrap all casings, regardless of whether the pipe is supposed to be insulated from them or not. Then, if an accidental short-circuit develops, perhaps several years later, the additional drain on the cathodic protection system is not as great as it would be with casings totally bare.

Care should be taken to obtain adequate separation between all crossing lines, and the best possible coating job at such places. The coating on the line crossed should be left in the best of condition, even if the original coating was poor. Bare lines should be coated where crossed, although extra excavation for the purpose is not recommended. All lines crossed should be very carefully recorded; some may be encountered that were not found in the original survey, and the same ones can easily be missed in later surveys, but there is no excuse for missing any while the ditch is open, unless indeed there are lines deeper than the ditch.

This is the proper stage of the project to see about the installation of test leads. At every road crossing, unless there are some very close together, and on both sides of major crossings, a pair of test leads should be attached to the pipe, and both wires brought up in a pipe marker, preferably set in a fence line. The distance between the points of attachment to the pipe should be sufficient to make it possible to measure current flowing in the line by the IR drop as indicated on a potentiometer. A good rule to follow is to make the distance between the two leads of a pair, in feet, equal to four times the weight of the pipe, in pounds

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per foot. This will give a pipe resistance of about one milliohm, so that the current in amperes will be numerically equal to the potential drop in millivolts. There should never be any fittings of any kind between the two leads of a pair—nothing but plain pipe. Care should be taken that there can never be any confusion as to which lead is which—a standardized color code for the two wires is an easy way to accomplish this. The locations and actual separations of all pairs of test leads should be carefully recorded. A copy of this record should be supplied to the clean-up inspector so that he may check the list to determine whether any leads have been lost in the backfiling. If one of the corrosion trainees can find the time, it is well to test all the leads as soon as possible, so any that have been broken may be repaired by the contractor.

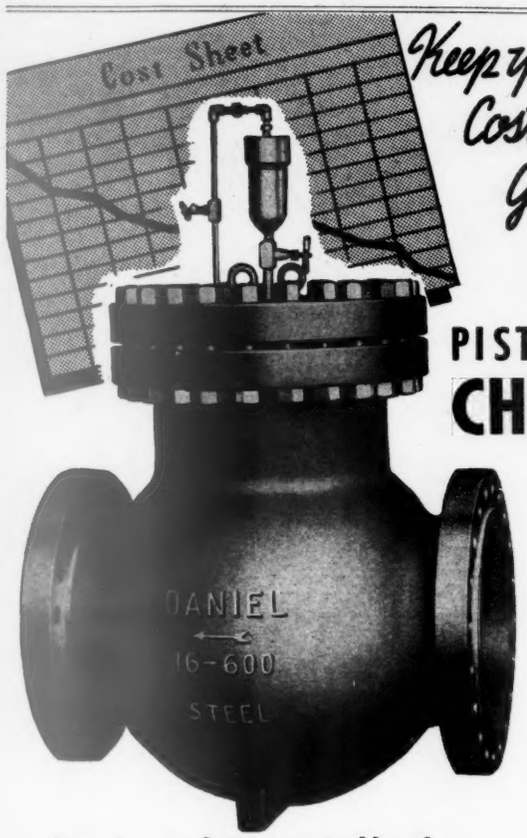
The next task to engage the attention of the new corrosion department is the organization of a system of maps and records. As soon as they become available, a set of the alignment maps or operating maps should be obtained from the engineering department, and all the field notes indexed thereon. The location of all test leads should be indicated, as well as all insulated joints. Any information gathered by the corrosion department, such as the location of crossing pipe lines or power lines, which has been missed by the department preparing the maps, should be called to their attention, so they may be added to the tracings. An extremely useful map for the corrosion department is one showing access roads—whether public or private, highway or trail—which may be used to reach the line at various points. If such a map is available from the operating department, it should be obtained. It will frequently devolve upon the corrosion department, however, to prepare one, in which case it should be made available to others—the corrosion department will need a great deal of inter-departmental good will.

Arrangements should be made for the corrosion department to receive copies of all work orders that could possibly affect the protection of the line. As those not fully acquainted with corrosion work cannot be depended upon to recognize the relationships involved, if it is at all possible, the department should have the opportunity to see *all* work orders. They should be seen early enough to permit the inclusion of insulating material if it is necessary or advisable. From these reports the corrosion department will keep up-to-date an electrical diagram of the line—not a map, but a circuit layout, functionally similar to the flow diagrams used by the operating department.

Other maps and records will be discussed later, in connection with the surveys to be recorded thereon.

Cathodic Protection System

Field tests for the determination of current requirements for cathodic protection cannot be run until the line has been given time for the settling and consolidation of the backfill, and for the penetration of moisture into the defects in the coating. Six months after the laying of the line is ample, provided at least two months have elapsed following a good rain. Otherwise field tests will show less current demand than will actually exist later. The waiting time should be spent in the compilation of the maps just discussed, and in further exploration of the possible ground bed sites located during the construction period. Preliminary studies of drain point distribution may be made, based on assumed current requirements for the line. A reasonable estimate for an excellent coating is 1 milliampere per square foot of bare metal, and 99 per cent effective coating, i. e., 1 milliampere for each 100 sq ft of pipe. Such a study may result in a spacing be-



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Valves, seats and pistons are stainless steel. Liners are hard chrome plated.

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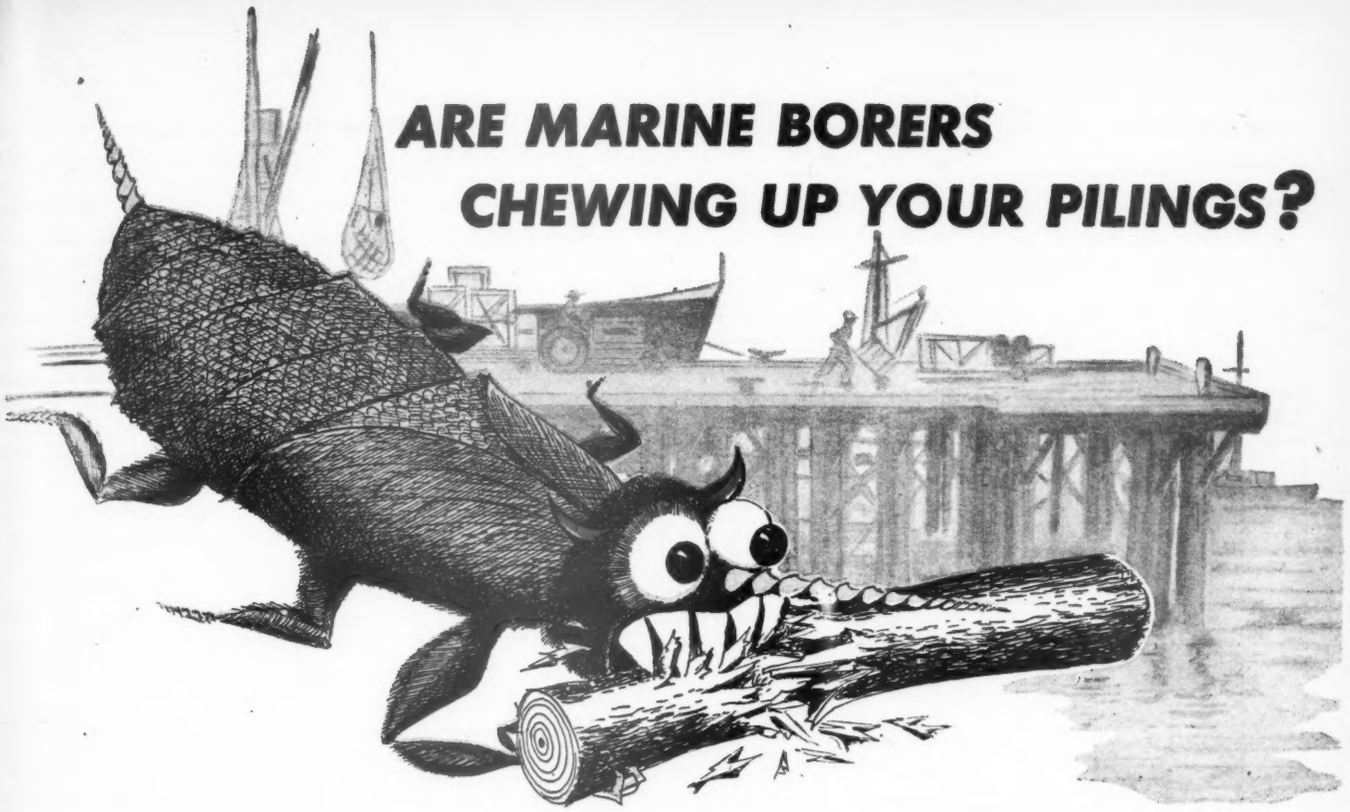

ARE MARINE BORERS CHEWING UP YOUR PILINGS?

Starve them with steel—plus NATIONAL graphite ground anodes!

NATIONAL TRADE-MARK

WHY GRAPHITE ANODES ARE BEST FOR CATHODIC PROTECTION:

- Complete and sure protection in sea water—indefinitely
- Positive control in any weather; just change a tap on the rectifier to raise or lower current input
- Perfect for use in high resistance soils
- Longest life of any anode material obtainable
- Thoroughly tested and proved in service for more than 20 years

If your dock facilities are subject to attack by marine borers, install borer-proof steel pilings, and protect those pilings from underwater corrosion by economical long-lasting "National" graphite ground anodes.

The anodes are lowered to the bottom and connected with a shore-based rectifier. Another wire from the rectifier runs to the steel pilings. When current is passed, it flows out from the pilings into the water—thus giving very complete cathodic protection. No matter how severe the corrosive conditions are, you can regulate the current to afford the proper protection, simply by adjusting the rectifier.

Other advantages of steel pilings are: more strength ... better fire resistance ... less maintenance ... lower insurance rates.

"National" graphite ground anodes also provide the most practical and economical cathodic protection for *buried pipe lines, tank farms, oil well casings, water mains, underground cables, ship hulls* and dozens of other products buried in earth or submerged in water.

Cathodic protection saves steel!

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RECTIFIER RECORD

NAME PLATE DATA

Manufacturer _____

Serial Number _____

D. C. Volts _____ Amps _____

A. C. Phase _____ Volts _____

Cooling _____

LOCATION DATA

Date Installed _____

Inv. Sta. No. _____

Property Owner _____

Investment Acct. _____

Expense Acct. _____

Date	A. C. SETTING				D. C. READINGS		Power Meter	Read by
	Primary		Secondary					
	Phase	Volts	Coarse H-M-L	Tap Number	Volts	Amps		

FIG. 1. Record sheet for rectifier unit. A pad of these mimeographed forms may be kept in a waterproof box at each isolated rectifier, so that all company employees whose duties take them by the unit may record readings. The corrosion department can then transcribe the record from time to time into their permanent records, kept on the same form.

MAGNESIUM ANODE STATION NO. _____

Date Installed _____ Inv. Sta. No. _____

No. and Type of Anodes _____ Shunt (ohms) _____

Depth _____ Resistor (ohms) _____

Backfill _____ Current _____

Soil Resistivity _____ Projected Life _____

STATION LAYOUT

RECORD

Date	Current	Date	Current

FIG. 2. Record sheet for magnesium anode station. Ties should be recorded to nearby identifiable objects in sufficient detail to permit relocation of all anodes and connecting wires.

tween drain points of, say, 30 miles. With this figure in mind, possible sites at this approximate spacing should be surveyed, and, where necessary, others sought to fill in gaps. First consideration should be given to those at which power is available.

An ideal ground bed location lies in soil whose resistivity is low, not only on the surface, but to great depth; one from 300 to 500 ft from the line, opposite a point where the line itself lies in relatively high resistivity soil, and at a location easily accessible and with power available. Starting with the idea of a set of such ideal locations properly spaced at the desired interval along the line, a series of compromises with reality must be made, until a tentative set of usable locations has been located. Some of the intervals will be greater than desired, others will be smaller; the use of rectifiers of different sizes must be anticipated.

A welding machine offers a very satisfactory source of test current. A temporary ground bed will be used, ordinarily consisting of a number of pieces of scrap 2-in. pipe set in augered holes kept filled with salt water during the test. The connection to the line should be made in such a way that it will serve later as the permanent connection. If the test site is not used, the connection should be such that it can be abandoned without great loss, and without appreciable damage to the line. A ⅜-in. by 1-in. square head steel bolt arc welded to the top of the pipe can be expected to carry far more current than will ever be drained from a coated line at a single location, and, if the joint is properly made up, will have an extremely low resistance. On the other hand, if the location is abandoned, the bolt may be left in place; thoroughly coated, it can cause no difficulty later on as no dissimilar metals are involved.

The welding machine should be put into operation as soon as the connection to the pipe is made and the first temporary anode set. In this way it will be possible to make the ground bed just large enough to drain the desired amount of current, which should initially be from 20 to 50 per cent greater than the anticipated value to be drained at this location by the permanent installation. A few hours' operation at this higher level will polarize a greater length of line; possibly as much as would be done by several weeks at the normal value. As soon as the test set is in operation, a rapid survey down the line in both directions, using the test leads previously described, will determine both the distribution of current and the extent to which protection is being extended. In the meantime, a similar test set should be put into operation at the next chosen site along the line.

After five or six hours of continuous operation of both sets, the current at each should be reduced to the estimated value. Conditions at this new value should stabilize within an hour or so, and it will be easy to determine the coverage of the section of line between the two sets. Appropriate adjustments of the current output should then be made, so that correct coverage is obtained. Assuming that the first test set is near an insulated joint

or the end of the line, and that three or more units are to be installed on the section under test, the next step is the transfer of the equipment from the first location to the third, the second set remaining in place. The entire procedure is then repeated, except that the current drained by the second unit should not be adjusted unless necessary.

Quite often, particularly on a well-coated line, there will be no more than two units in a given section. If suitable soil can be found, it is distinctly advantageous to place the units at the pump or compressor stations themselves. This usually will result in lower power rates, and will inevitably effect closer supervision and better maintenance.

The test procedure outlined above assumes that the tentatively selected sites are in fact adequate for the protection of the line with rectifiers of reasonable capacity. This will not always be the case. New locations must be sought, which usually means those less satisfactory, either from the standpoint of soil resistivity, accessibility, or power availability. Sometimes the best economic solution is the increased drainage from chosen locations, rather than additional sites. It may be possible to abandon some sites, and slightly increase the size of others. All of these complex possibilities have to be worked out, and usually they may be worked out at far less cost if they can be solved in the field. In other words, this particular survey is not one that can be carried out effectively according to a pre-arranged plan and by technicians only. The services of a competent corrosion engineer are required for at least part of the time.

If it is impossible or impractical to operate two test sets simultaneously, the data can be obtained with a little more trouble and a little less precision with only one. The procedure is as follows: The probable point of least protection is determined (for a uniform line in uniform soil, this would be the mid-point between units of equal size), and pipe-to-soil potential readings taken for a short distance on each side *before* the test unit is operated. Readings are taken at these same points with the unit in operation at what is thought to be the proper drainage current, and again under the same conditions with the second unit in operation, or rather the same unit at the second location. The net potential that would be reached by the simultaneous operation of both units is then taken to be the original potential plus the net change obtained by each unit operating alone. Plotting these values for the several points along the middle of the section will readily disclose whether or not full protection is being obtained. If this is not the case, and if the discrepancy is very great, then some locations may have to be re-occupied. This is where the extra effort is involved.

The completion of this portion of the survey will provide a list of the rectifier sites, and the current rating of the unit to be used at each one. The current rating in each case should be at least 50 per cent greater than the estimated requirement. This additional capacity will cost little, and will always be available in case of unexpected increase in demand. It remains to design a ground bed for each site, and, incidentally, to determine the voltage rating of each rectifier. The ground bed should be designed for the actual anticipated current, with the idea of enlarging it should more current become necessary, for, although additional capacity is relatively inexpensive in the rectifier, this is not the case in the ground bed.

The most economic design of a ground bed with a specific current rating at a specific site represents one whose total annual cost is a minimum —the total cost being made up of the amortization and depreciation charges

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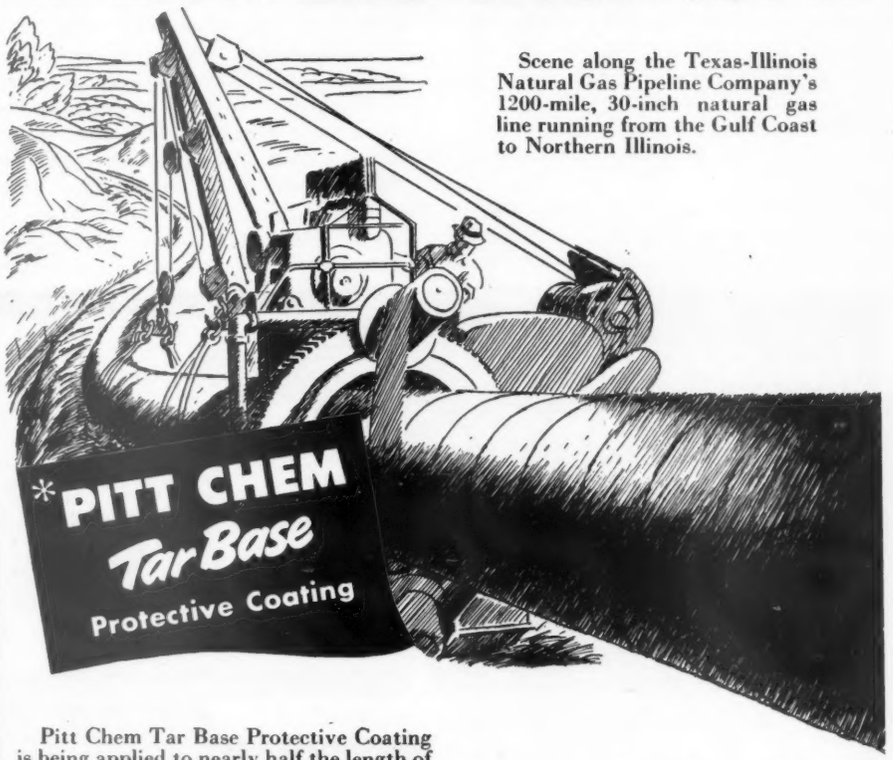

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against the invested capital, plus the power costs and the expense of maintenance. Among the variable quantities are the size, number, and spacing of the anodes, the size of the cable by which the connections are made, and the kind and quantity of backfill used around the anodes. A reduction in any one of these three items will result in a reduction in first cost, and an increase in operating cost; therefore there exists, in theory at least, a choice of the most economical elements. Where the balance point falls will depend upon a number of factors, normally fixed for a given location: Interest, amortization and tax rates in use by the company, permissible returns on invested capital, the cost of power at that particular site, and the resistivity of the soil at that location, both at the surface, at anode depth, and at great depth.

It must be pointed out here that frequently the cost of power, the cost of obtaining power (by line extensions), and the resistivity of the soil, are factors that may enter into the choice between two or more possible sites, but these comparisons can usually be carried out only by completing the design, at least approximately, at both sites.

The voltage required of a rectifier to drain a given amount of current is determined by the total circuit resistance. This, in turn, is made up of three parts: (1) The resistance to earth of the pipe line; (2) the resistance in the connecting cables from pipe to rectifier and from rectifier to ground bed, and (3) the resistance to earth of the ground bed. The first resistance is fixed for a particular line at a particular point, although it will increase after the line is brought up to complete protection, through polarization; the second is determined by the choice of cable, and the third is to a certain extent controllable, being determined by the soil resistivity and the ground bed design. If the material used for the anodes is different from that of the pipe line, an additional voltage may be required to overcome the galvanic potential; e. g., carbon or graphite anodes require from 1.0 to 1.6 volts, depending on the backfill used.

Material for the ground beds is usually limited to scrap pipe, scrap cast-iron in large pieces, and carbon or graphite anodes. The use of scrap iron or steel is declining rapidly, because of the higher cost of scrap, and because pipe lines so often have been using corrosion control methods so effectively that they no longer have vast quantities of unusable pipe on hand. The details of calculating the resistance of different types of ground beds have been adequately treated.[1 2 3] Several tentative calculations may have to be made on each location, or the following approach (for graphite rods) may be used.

The size of rod to be used having been selected (or the process may be repeated for each size) the number of rods required for the load is determined from the maximum permissible current per rod. The resistance of a bed of this number of rods is then computed, using a spacing of 20 ft. From this the voltage required follows, and this in turn allows the power bill to be computed (rectifier efficiency may be assumed at 50 per cent). With this as a starting point, the cost of adding one anode is compared with the saving in power costs it will effect. The process is continued until the point is reached where one additional anode costs more than it will save. A similar process may be devised for use of more expendable anodes of scrap metal; the starting point would be the length of pipe whose anticipated life would be, say, 10 years.

The rectifier should be selected with a voltage rating somewhat higher than the one arrived at by the above process. It will then be possible to make temporary increases in the current output by merely raising the voltage,

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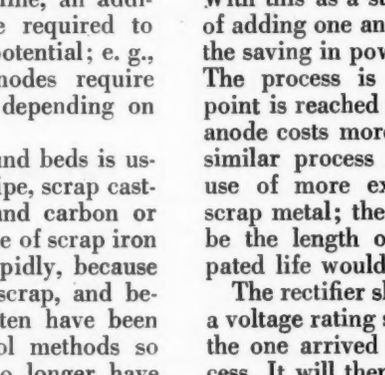
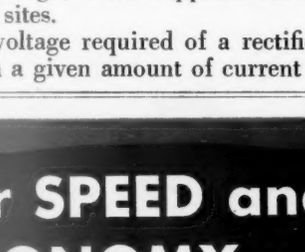


ATTACHMENTS



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although this will involve operating at higher costs than the possible minimum. It will also make it possible to raise the voltage in order to maintain the designed value of current during periods of excessively dry soil, when the ground bed resistance becomes temporarily higher than normal.

The possibility of using expendable anodes of magnesium should not be overlooked. This form of cathodic protection is particularly valuable in sections where power lines are not available, for supplementing the coverage in cases where two adjacent rectifier locations do not quite reach the mid-point, and in long stretches of low resistance, swampy territory difficult of access. The total current required to protect a given line section with magnesium anodes is usually quite a bit lower than that required by the larger and more widely spaced drainage points associated with rectifiers, simply because there is less current wasted in over-protecting the pipe in the immediate vicinity of the drainage points. On the other hand, the cost per ampere is higher with magnesium. These two opposing factors call for an economic study similar to those mentioned earlier.[4]

The direct supervision of the installation work, whether it is done by company forces or by independent contractors, should fall to the corrosion engineer trainees. If company forces are used, there will probably be no formal specifications, and closer supervision will be required; there is the compensating advantage that the detailed design may be modified in the field to conform to conditions as found. Among the details to be checked carefully are the following: All connections must be made so as to have very low resistance; lugs to be bolted should be filed flat and smooth and made up very tightly, and soldered joints must be well bonded over a large area. The coke breeze backfill used around graphite anodes must be tamped with extreme thoroughness; follow the manufacturer's recommendations carefully in this respect. It should not be necessary to point out that the designed spacing should be followed, unless radical changes in anticipated conditions are encountered in the field.

The correct installation of magnesium anodes, where these are called for, cannot follow preconceived plans so explicitly. This is due in large measure to the fact that it is virtually impossible to design a good magnesium installation in the office; rather, it is not economically feasible to obtain the detailed information in the field, upon which a complete office design might be based. Accordingly, it is advised that a preliminary installation be made of approximately two-thirds of the number of anodes estimated to be required. This installation may be made by crews who have received a minimum of instruction. After this system has been in operation for a few weeks, a pipe-to-soil potential survey, including also the current output of the various anode groups, will disclose quite accurately the extent of coverage being obtained, and an experienced corrosion engineer will be able to prescribe the number and distribution of the additional anodes required. Experience has shown that this combination of studied design and final tailoring to measure in the field is the most economical approach to cathodic protection with magnesium anodes.

One of the duties of the engineer trainees in this phase of the work should be the making of accurate records, whether rectifiers or anodes are being used. Exact locations of all anodes, connecting wires and cables, pipe connections, and any auxiliary structures, should be recorded in the field books, along with the various readings taken. Later these will be incorporated into operating records, to be described in the next section.

Operating Maps, Records

Some of the permanent records of the corrosion department have already been described under the heading "Maps and Records." Immediately following the installation of the protective system, a set of operating records should be set up for each unit. It is advised that separate records be kept for the rectifier itself and for the ground bed at a given site, as the rectifiers may be transferred or replaced at some time. The voltmeter and ammeter on each unit should be read as often as convenient; a minimum of one reading per month is advised. In order to make this record as complete as possible, provision should be made for these two values to be recorded by almost any company employee whose business takes him to the vicinity of a unit at any time. A set of record sheets in duplicate may be placed, with a pencil, in a small waterproof box attached to the unit, and general instructions sent out for all employees to make a record of the voltage, current, and date thereon whenever they are passing by. The corrosion department may collect these sheets from time to time and enter the readings on their office record of the unit concerned.

Instructions may be attached to the sheets at the unit, addressed to all employees, to notify the corrosion department immediately if readings are

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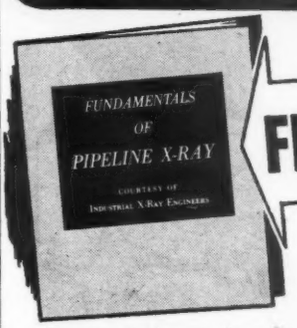

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found that fall outside of a given range. These suggestions apply to isolated units. Where the installation is at a pump or compressor station, the station personnel should take and record daily readings.

There will be far fewer readings on the ground bed record; there is no occasion to investigate the performance of this part of the system in detail, as long as the current is being discharged at the desired rate without requiring excessive driving voltage. A sudden drop in the current output of a rectifier, with voltage remaining normal, is indicative of the disconnection of one or more anodes. A survey of the surface potential field with a copper sulfate electrode, the connection to the other terminal of the potentiometer being fixed at one location—either at a remote copper sulfate electrode, or on the anode cable at the rectifier—will readily distinguish between the anodes that are discharging current and those that are idle. The cable break must then be found by excavation.

An electrical profile of the line should be prepared. On it should be shown all pertinent physical data—the pipe size and weight, all casings, crossings, bonds to other structures, and possible interference exposures. The locations of all cathodic protection units and test leads should be indicated. If there is any variation in the type or thickness of coating, this too should be indicated. Insulated joints must also be shown.

On the profile itself there will be plotted a graphic presentation of the pipe-to-soil potential and of the line currents throughout the length of the line. Soil resistivity data should be entered where such surveys have been run. It is not normally economical to conduct complete soil resistivity surveys on coated lines. Any leaks that occur on the line should be shown, as well as all maintenance and repair work done. This type of record is more likely to be used on an old line than on one with the comprehensive control program here being described.

It is suggested that this electrical profile be kept up-to-date on tracings, and that record prints be made at yearly intervals. There is little choice as to whether this profile should be made on a continuous strip or in sheet form; sheet records are more convenient, but also more expensive to make and to maintain.

Operating Conditions

The regular duties of the corrosion department, after the original installation of the cathodic protection system, are limited to surveys and maintenance, unless, of course, new construction involves a partial repetition of the original schedule. A pipe-to-soil potential survey should be run over the entire line at least once a year, using the test leads. Line currents are to be measured at the same time. So long as these surveys show no abnormalities, no more detailed investigations need be made. When potentials near the mid-points between units are dangerously close to the protective level, intermediate readings may be justified. Trends should be carefully noted, in order that additional protection may be planned in advance of actual need. It should be the aim of the corrosion department to maintain full and complete protection throughout the entire length of the line, as nearly as possible without interruption. If this can be accomplished, the space for the recording of leaks may well remain vacant year after year.

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2. "Location and Selection of Anode Systems for Cathodic Protection Units," D. B. Good, *Corrosion*, 3, 539-548 (1947).
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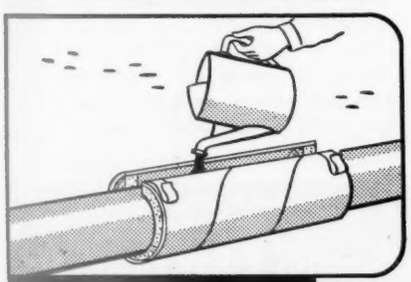
★ ★ ★

FIELD JOINTER
PAT. APPLIED FOR

Slip on - Pour full - Lower in

OLD METHOD



NEW METHOD

"Field-Jointer" construction features heavy, rigid, paper mould equipped with felt inserts for each end, preventing waste, plus heavy adhesive tape fasteners. One-quarter inch spacing between pipe and mould gives positive assurance of protection. Slip on—Pour full—Lower in.

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★ Operates simply requiring no skilled labor
★ Affords positive proof of pipe-bottom protection
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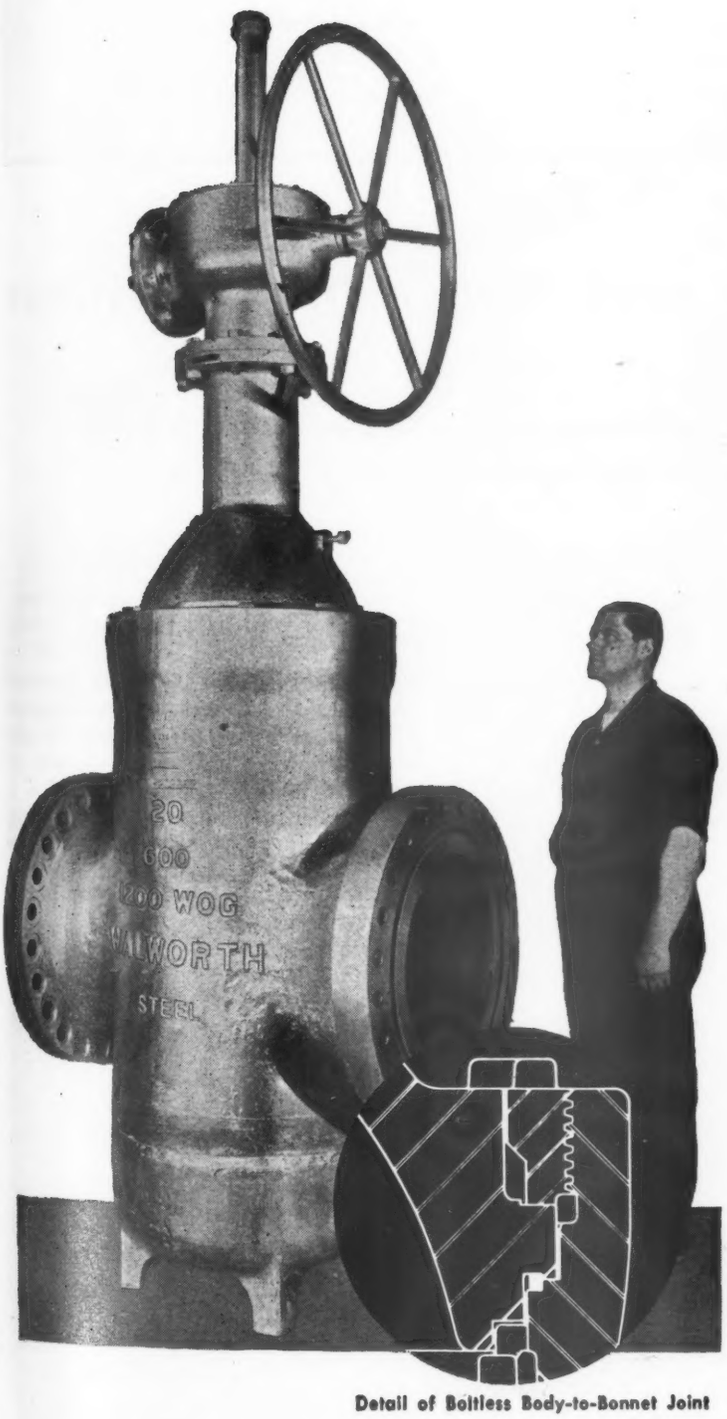
(PATENT APPLIED FOR)



Detail of Boltless Body-to-Bonnet Joint

These new Walworth valves have been designed on the through-port principle, with body and disc ports accurately indexed, and body ports bored to match connecting piping. These valves have no recesses to accumulate dirt and no obstructions to interfere with the free flow of liquid or passage of pigs or scrapers. Furthermore, these valves do not require any internal lubrication and may be installed without regard to flow direction. Walworth Type 49 Steel Pipe Line Gate Valves are made in sizes up to and including 30" in Series 400 and 600. Valves have stellite seat rings, and the body-to-bonnet joint incorporates a Walworth boltless design. A detailed illustration of this joint is shown here.

For further information about these new Type 49 Steel Pipe Line Gate Valves, contact your nearest Walworth distributor.

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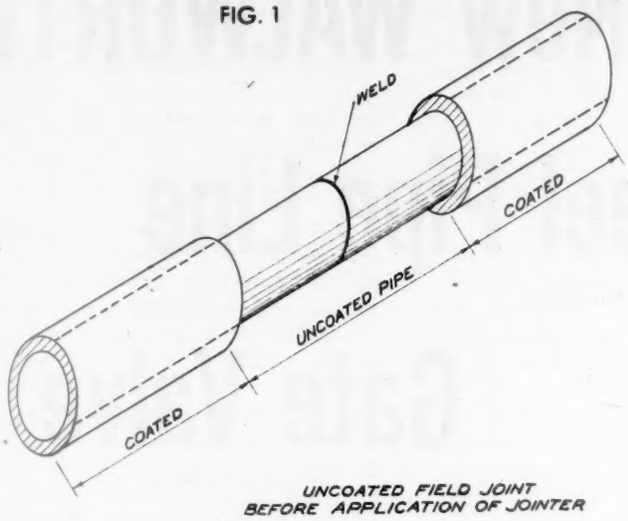
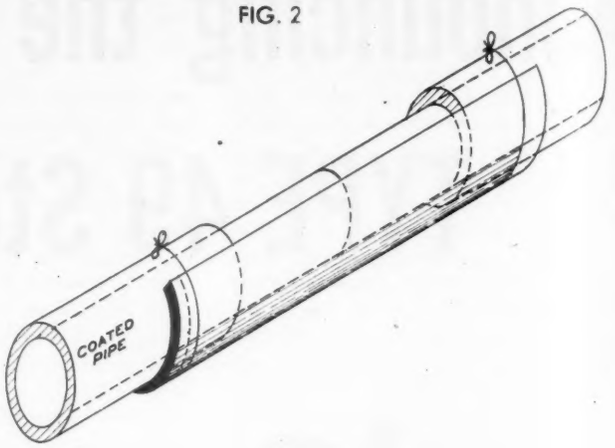
FIG. 1



UNCOATED FIELD JOINT BEFORE APPLICATION OF JOINTER

FIG. 2



JOINTER IN POSITION FOR APPLICATION OF COATING

Coating Field Joints and Repairing Coatings

New method solves serious problems in pipe line construction —proper coating of field joints and repairing damage by skids

W. E. HUDDLESTON

In the past, pipe line organizations have continuously been faced with two outstanding problems in connection with general pipe coating operations, namely (1) how to coat field joints properly when laying mill or yard coated pipe, and (2) how to repair "skid marks" and other portions of a completed coating job following over-the-ditch coating operations.

Yard and mill coating techniques have been notably improved during the last few years, and such items as pre-drying of the pipe, grit blast cleaning, thermostatically controlled heating of the enamel, and other improvements have made it possible to obtain virtually a perfect application of the various required coating materials. Improved methods in the manner of handling, racking, loading, and unloading of mill and yard coated pipe have made it possible to maintain the coating in almost perfect condition up to that stage of construction where the coated pipe is on skids over the ditch, with the joints having been welded or screw-coupled in readiness for the final coating operation. (Refer to Fig. 1).

The application of enamel and a protective shield over the uncoated field joint has always presented a cumbersome problem, with the result that it has sometimes been impossible to complete the final coating operation and ultimately procure an overall coating job that is commensurate in quality with the workmanship obtained during the earlier stages of construction. The procurement of a high quality completed pipe coating job might well be contingent upon the manner in which the field joints are coated, regardless of the heavy

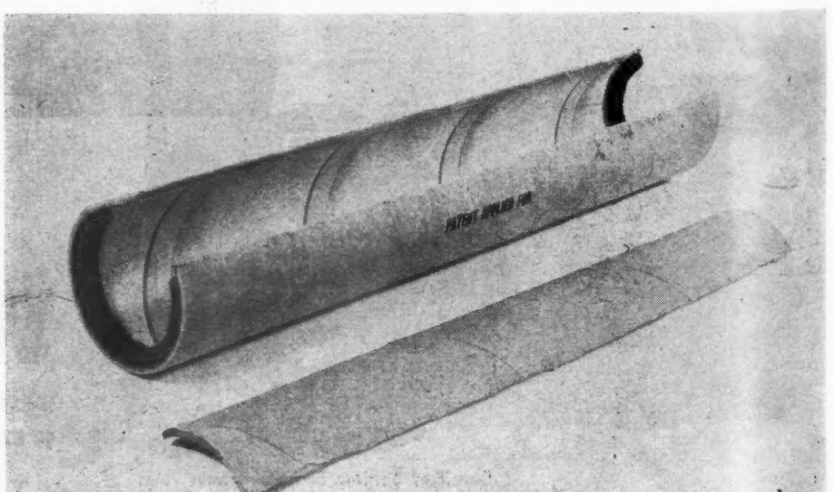


FIG. 2. Pipe coating jointer.

EXCLUSIVE

investment in materials and their application at the outset of the pipe line project under consideration.

Use of the Jointer

A device known as a field jointer has recently been developed for use in coating pipe joints in the field. Fig. 2 shows a photograph of a jointer that is made for coating either welded or screw-coupled joints of 2-in. mill or yard coated pipe. This device is essentially a split cylinder of heavy cardboard material, equipped with sealing gaskets and tie strings at both ends. The small piece shown in the photograph is a segment of the same material, and this piece is supplied for use in shielding the top portion of the completed field joint coating job.

The following procedure is recommended for coating a field joint with use of the jointer: (1) clean and prime the bare portion of pipe at the joint in the usual manner; (2) after the primer has dried place the jointer around the pipe, open side up, and positioned so that the uncoated portion of pipe is situated between the ends of the jointer, and attach jointer securely to the pipe with use of the tie strings as illustrated in Fig. 3; (3) pour enamel over the top of the uncoated pipe, allowing the enamel to run down the sides of the pipe and fill the jointer until the top of the pipe is adequately covered with enamel. This completes the operation.

Obviously, the jointer will facilitate the attainment of enamel thickness (on the top side of the pipe) in excess of the thickness that is used for most pipe coating jobs, and it is felt that this added thickness of enamel will strengthen the completed joint sufficiently to obviate the need for top side shielding. If, however, the pipe line operator elects to provide added shielding he may do so by placing the heavy cardboard cap (illustrated in Fig. 2) over the exposed coating.

The jointer fills the dual purpose of serving as a mold for the hot enamel and providing a mechanical shield for the completed joint. The enamel will solidify within a very few minutes following the pouring, after which the completed joint may be tested with an electric holiday detector and the pipe lowered into the ditch. The period required for enamel cooling will range from 2 to 8 min., depending upon such variables as the enamel temperature, type of enamel being used, and the prevailing atmospheric temperature.

Fig. 4 is a photograph of a completed coating job on a screw-coupled joint without the use of the shielding cap. Figs. 5 and 6 show the distribution of enamel around the pipe at a completed field joint; the jointer having been carefully removed for inspection purposes.

Economics of Jointer

With the exercise of reasonable discretion during the coating of a field joint the jointer will facilitate completion of the job quickly, thoroughly, and economically. No special skill is required to coat field joints with use of the jointer. On small and medium sizes of pipe two men can normally complete the coating of all

The Author

Wm. E. Huddleston, pipe line corrosion consultant, has had 19 years' pipe line experience, 15 years of which have been devoted exclusively to the prevention of external pipe line corrosion. He is a graduate of the University of Nebraska with a BS degree in electrical engineering. During the last 7 years he has installed cathodic protection on approximately 4000 miles of pipe lines. His residence is in Bartlesville, Oklahoma.

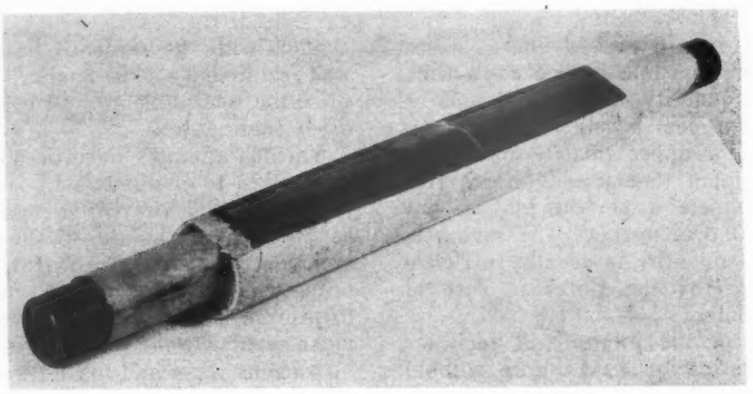


FIG. 4. Completed coating on field joint.

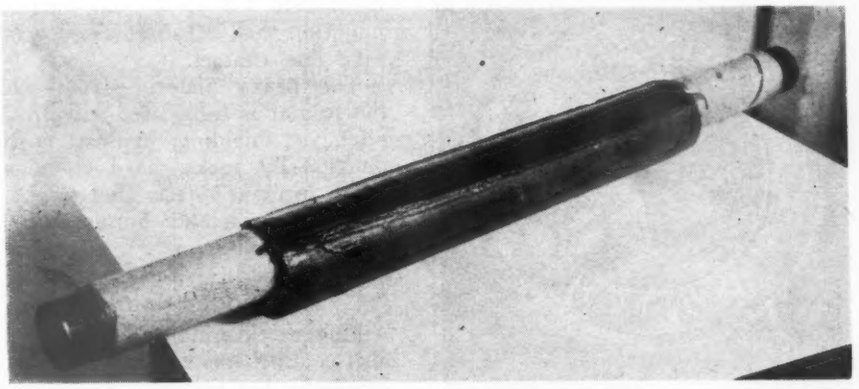


FIG. 5. Distribution of enamel on top and sides.

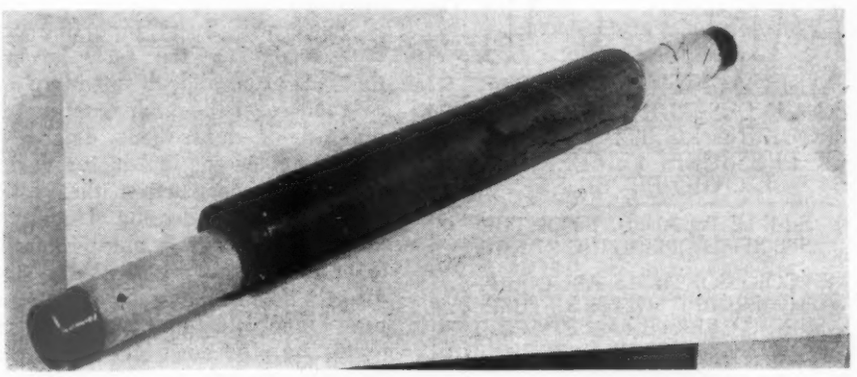


FIG. 6. Distribution of enamel on bottom and sides.

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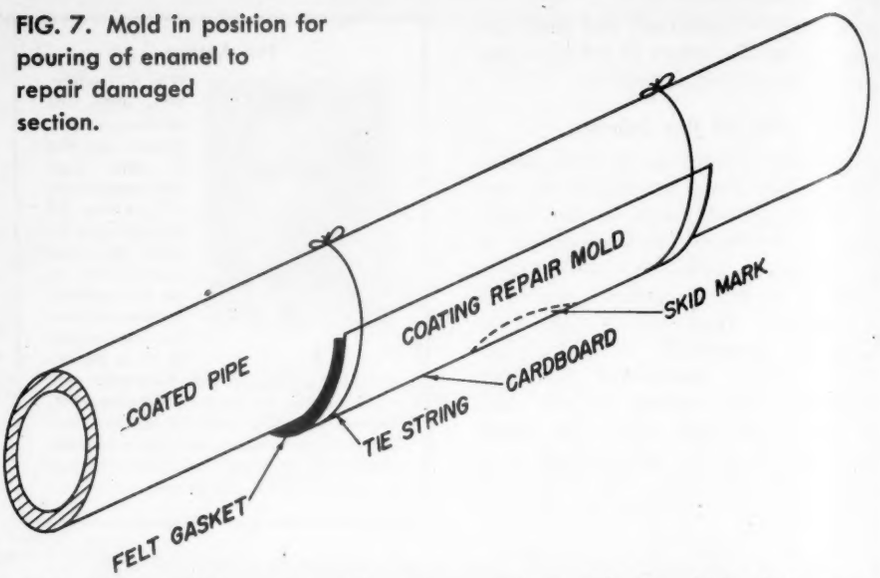

FIG. 7. Mold in position for pouring of enamel to repair damaged section.

field joints within a one mile section of pipe line in one day's time.

The quantity of enamel that is required to coat a field joint with this device is approximately one-fourth the amount that would be required to complete a perfect job by any other known method. The saving in enamel quantity is usually sufficient to pay for the purchase cost of the jointer.

Use of the jointer will facilitate the coating of field joints without spilling so much as a drop of enamel. Waste is thereby eliminated entirely, and the pipe line right-of-way may be maintained free from the usual pollution that is caused from wasted pipe line enamel.

The heavy material from which the jointer is fabricated will provide effective shielding against coating damage by rocks, hard clods, and other foreign objects that might be present along the bottom of the pipe ditch.

Damaged Coatings

Modern cleaning and priming and also coating and wrapping machines facilitate the application of coating materials to obtain almost a perfect over-the-ditch coating job insofar as application of the coating materials is concerned. Every pipe line operator recognizes the fact, however, that it is often difficult to end up with a good over-the-ditch coating job because of subsequent damage to the completed coating during various phases of construction that follow the machine application. Under certain conditions it is not permissible to cradle coated pipe into the ditch directly behind the coating and wrapping machine operation. Accordingly, the pipe must be cradled onto the skids directly over the ditch for subsequent lowering in, with the result that the coating is damaged from contact with the skids. It has been well said that "skid marks" comprise the weak link in most over-the-ditch coating jobs.

Various attempts have been made in the past to eliminate skid damage, including such preventive measures as padding at the skids. The most common approach, however, has been to entirely forego any attempt to prevent skid damage, and instead make repairs to the damaged coating by various ways and means, most of which have proved unsatisfactory.

Coating Repair Mold

"Skid marks" and similar damages to pipe coating may be repaired with the use of a coating repair mold as illustrated in Fig. 7. This device is similar in construction to the jointer except that it is designed to cover only the bottom side of the pipe to facilitate repair of normal skid marks. The recommended procedure for making skid mark repairs with the coating repair mold is as follows: Cut the shielding wrap from around the damaged section for at least 1 in. back from the edge of the original enamel in order to permit the new enamel to fuse with the original enamel; place the repair mold around the pipe, open side up and centered over the damaged section, then tie in position with use of the tie strings. Pour enamel over the top of the pipe directly above the break and allow the enamel to run down the sides of the pipe and into the mold until it is full. Allow sufficient time for the enamel to entirely solidify in the completed repair before lowering the pipe into the ditch.

The repair mold is made in a standard length, and in addition, some are made in double the standard length to facilitate repairs to damaged sections that are unusually long.

* * *

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How long has this type material been in use?		For almost 30 years.
Are data covering long time testing of this material available?		Yes, by the American Gas Assn., the National Bureau of Standards, and the A.P.I. tests in 1930.
Is it a positive shield against soil stress?		Yes. It is at the outside, partially imbedded, and at the point where needed.
Does it reinforce the enamel?		Yes. Its strong fibers lend needed reinforcement.
Does it tighten coating to the pipe?		Yes. It is a strong, thick sheath of asbestos in solid roll lengths.
Is it moisture resistant?		Yes. Tar saturant is moisture resistant. Asbestos fibers are solid, not tubular or hollow.
Does it have high fiber count?		Yes. A natural characteristic.
Is it uniform?		Yes.
Does it have high impact resistance?		Yes.
Does it apply easily and evenly?		Yes. Accurate mat make-up gives precision laps.
Does it prevent backfill damage?		Yes.
Does it prevent lowering-in damage?		Yes.
Does it give an even thickness of enamel on top, bottom and side of pipe?		Yes.
Is it a protection for the coating beneath it?		Yes. It stops damage at the outside—before it starts.
Does it prevent damage from abrasive movement coating receives in shipping or handling?		Yes.
Does it stick in the rolls?		No.
Does it have high tensile strength?		Yes. Lengthwise—44 to 52 lbs.; Sidewise—15 to 21 lbs.
Does it relieve gas bubbles?		Yes. By compressing action.
Is it chemically resistant?		Yes. Both asbestos and tar are very inert to most corrosive forces.
Can holiday detectors be run freely over its surface?		Yes.
Can it take rough, abusive handling?		Yes.
Does it irritate workmen?		No.
Is it a foreign material in the enamel?		No.

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The crossing of the Mojave River near Barstow was done during the dry season. Two 26-in. Somastic-coated lines were anchored with concrete weights. In this picture only the bottom halves are in place.

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Construction of PG&E's large-diameter line, crossing desert sands and mountainous terrain, called for special equipment and methods

RICHARD FINNIE

WHEN the Pacific Gas and Electric Company decided to increase its supply of natural gas by as much as 400,000,000 cu ft a day to meet the growing needs of central and northern California by drawing from the fields of West Texas and New Mexico, engineers determined that a pipe line greater in diameter than any ever before fabricated for such a purpose would be economical. Tying in with a network of smaller feeder lines running through Texas, New Mexico, and Arizona, it would be some 500 miles in length and 34 in. in diam. It would start near Needles, on the California side of the Colorado River opposite Topock, Arizona, and end at Milpitas, at the southern end of San Francisco Bay. The cost would be $63,000,000.

Although awarded on a competitive-bid basis, the contract for the construction of what was to become known as the "Super Inch" could not have come into more eligible or appropriate hands: Bechtel Corporation of San Francisco, through its affiliate, International Bechtel, Inc., was already building the major portion of the Trans-Arabian Pipe Line system, the world's greatest artery for the transmission of crude oil—a 30 and 31-in. pipe line running from the Persian Gulf 1068 miles to the Mediterranean.

There were points in common not only between the sizes of pipe and the special equipment called for, but also in the climatic conditions and terrain to be traversed. Almost half

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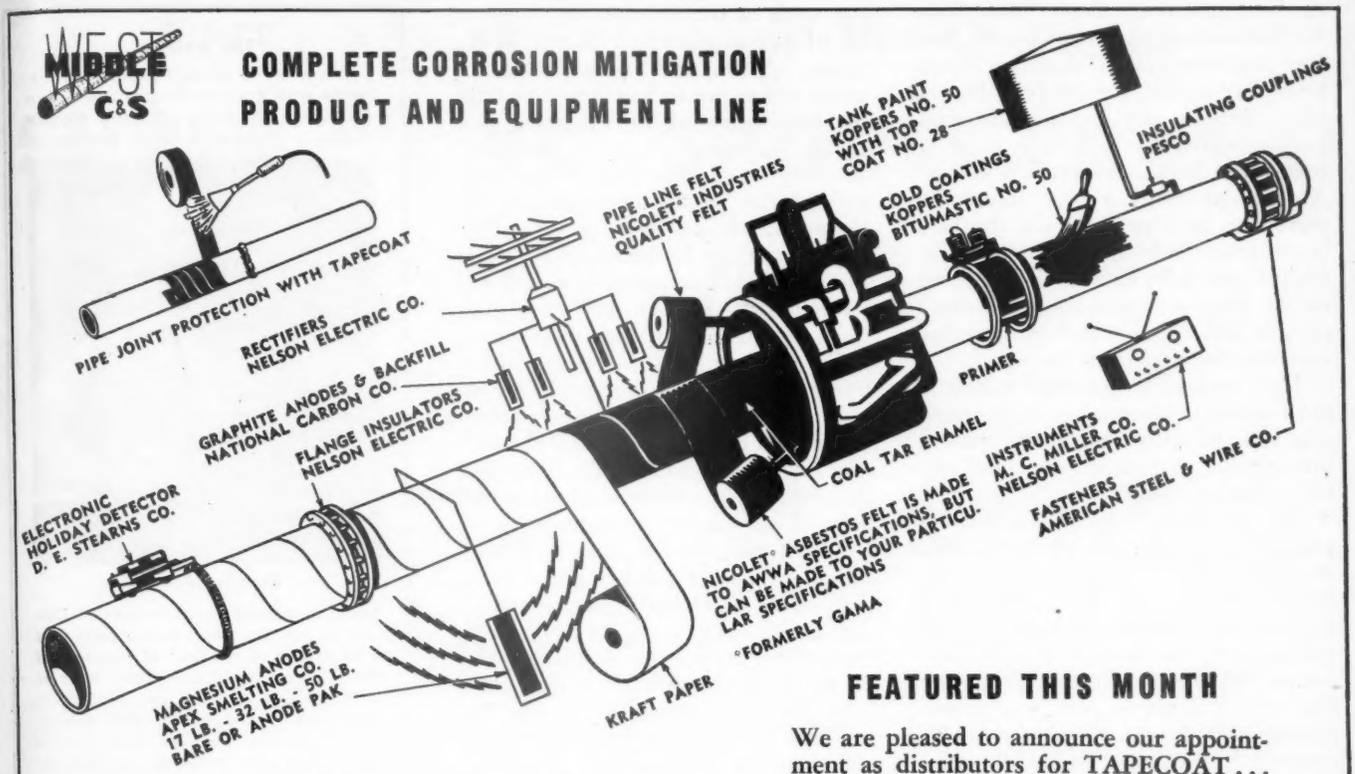
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of the route of the Super Inch, from the Colorado River westward to Barstow and over to the Tehachapi Mountains, lay across the Mojave Desert, where intense dry heat, sandstorms, and the scenery were notably reminiscent of the Tapline route across Saudi Arabia—as many a pipe liner who served on both projects was destined to observe. Only the wandering Bedouins and their camels were lacking on the Mojave Desert to round out a picture that would make either region indistinguishable from the other.

The similarity, however, ended at the Tehachapi Mountains, on the western side of which the route passed through flat, irrigated farm land and hilly grazing country.

The construction schedule was planned to avoid, as much as possible, the high summer temperatures of the Mojave Desert and the winter rains between Bakersfield and Milpitas, and also to complete first the 80-mile portion of the pipe line to San Francisco Bay, which could be put into service immediately by drawing temporarily from the Kettleman Hills field through an existing line.

Steel plate from the Geneva Steel Company mill near Salt Lake City was shipped to the South San Francisco plant of Consolidated Western Steel Corporation to be fabricated into 34-in. joints varying in length from 30 to 32 ft. To withstand the pressures to which they would be subjected between stations along the line, the walls of the finished pipe were to be of five thicknesses: $\frac{5}{16}$-in., $\frac{11}{32}$-in., $\frac{3}{8}$-in., $\frac{7}{16}$-in., and $\frac{1}{2}$-in. Using the same technique it had developed for the fabrication of 30 and 31-in. pipe at its Maywood plant, Consolidated Western at South San Francisco welded the joints longitudinally by the automatic shield-arc process, then expanded them hydraulically in huge dies to make them perfectly round and straight and to test and strengthen them by increasing their yield point.

For the northerly increment of the line, the joints were trucked to a yard at Santa Clara, where they were double-jointed by a combination of hand- and machine-welding. Truck-trailers then carried the 60-ft sections to the right-of-way in the Panoche Hills.

Meanwhile, earthmoving and pipelining equipment was brought from a rail siding at Hollister, and ditching got under way on June 29, 1949, thirty-three miles to the southeast. The 80 miles thence through rough Panoche Pass and rolling range country to Milpitas control station were spanned in about four months.

The main spread now transferred to Topock and began working westward. At the same time, the pipe-jointing plant was moved from Santa Clara to Barstow, where it was readied to receive rail shipments from South San Francisco.

Later, an auxiliary spread was detailed to lay pipe through an irrigated, heavily cultivated area near Bakersfield. This operation was timed to take place during the off season for crops, before planting.

At the Colorado River, where the 34-in. line begins, the elevation is 500 ft. The right-of-way climbs the Sawtooth Mountains just west of the river and reaches an elevation of 3200 ft in 30-odd miles. At Amboy it drops to 800 ft. Near Barstow it crosses the Mojave River. In the Tehachapi Mountains it attains 4600 ft and in 25 miles, in a series of roller-coaster grades, it descends to the San Joaquin Valley near Arvin, where the elevation is 200 ft. It crosses the Kern River southwest of Bakersfield and traverses farm lands and sage-brush plains to Kettleman Hills without rising more than 300 ft.

Behind the bulldozers clearing the right-of-way were 32½-ton ditching machines, the largest ever built, opening a trench 5½ ft deep and 47 in. wide, moving at a rate of a mile or more a day. Backhoes and draglines were used wherever the ground was too rocky for the ditchers, and here and there drilling and blasting had to be done.

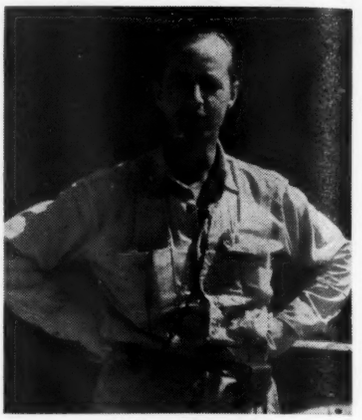
For months, trains of 25 to 40 flatcars, each carrying a dozen joints, rolled onto the siding near Barstow, where especially designed fork lifts unloaded the pipe onto skids at a rate of 30 carloads a day.

The triple-jointing procedure was

Lowering-in operation on the "Super Inch" line. Sideboom tractors were rebuilt so they could lift as much as 80,000 lb apiece. Continuous pipe strings up to 4500 ft in length were thus lowered in.

The Author

Enjoying the unusual position of historian with Bechtel Corporation, San Francisco, and its affiliates, Richard Finnie is the author of a number of



Richard Finnie

books and many magazine articles. During the past few years he has commuted from Alaska to the Gulf of Mexico and from California to Saudi Arabia to cover outstanding construction projects in word and picture. He has shot, written, and produced documentary films in sound and color on various subjects including the construction of the Alaska Highway and the Canol Project, the Trans-Arabian pipe line, the Edmonton-Great Lakes pipe line, and the P. G. & E. "Super Inch" pipe line.

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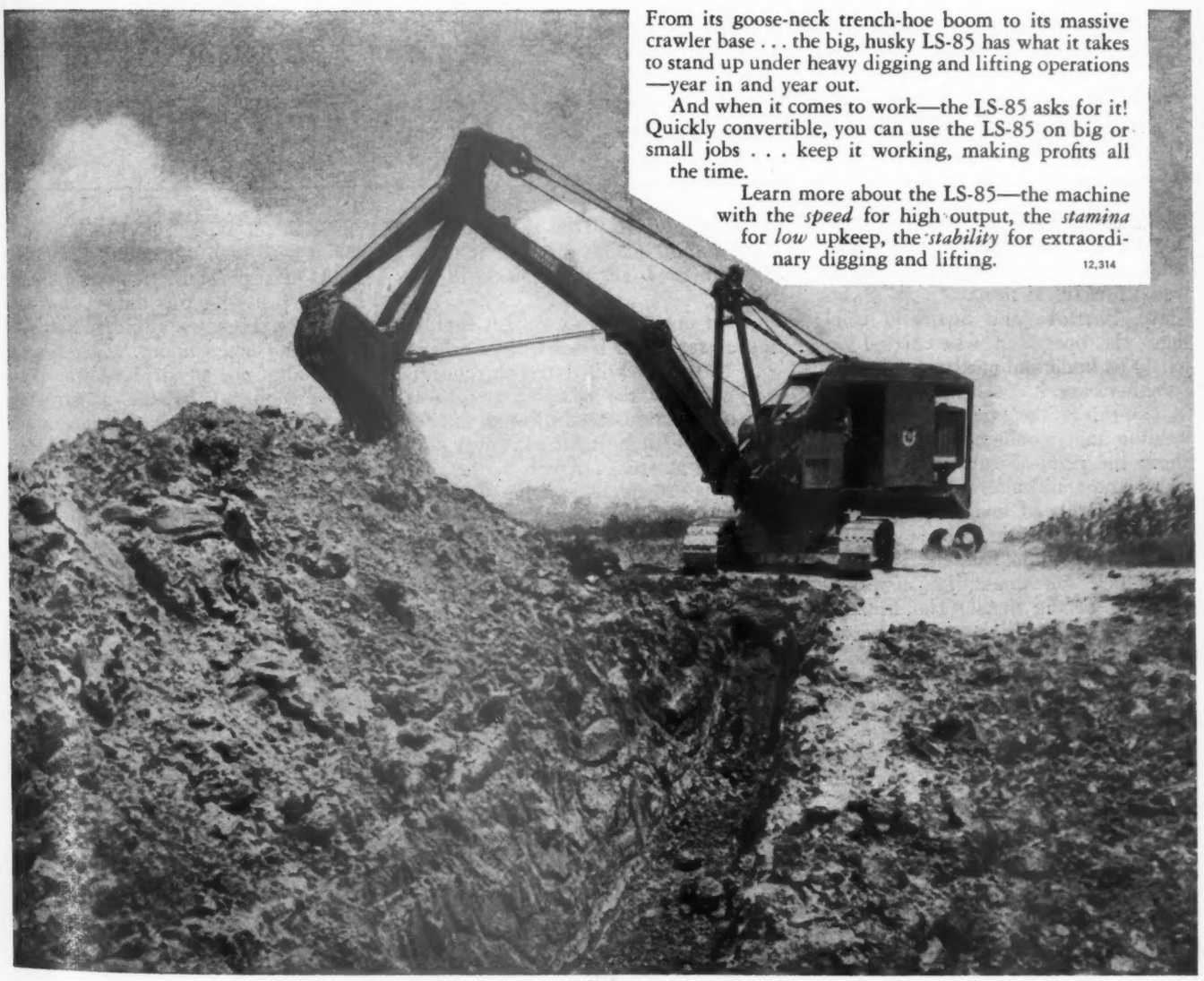

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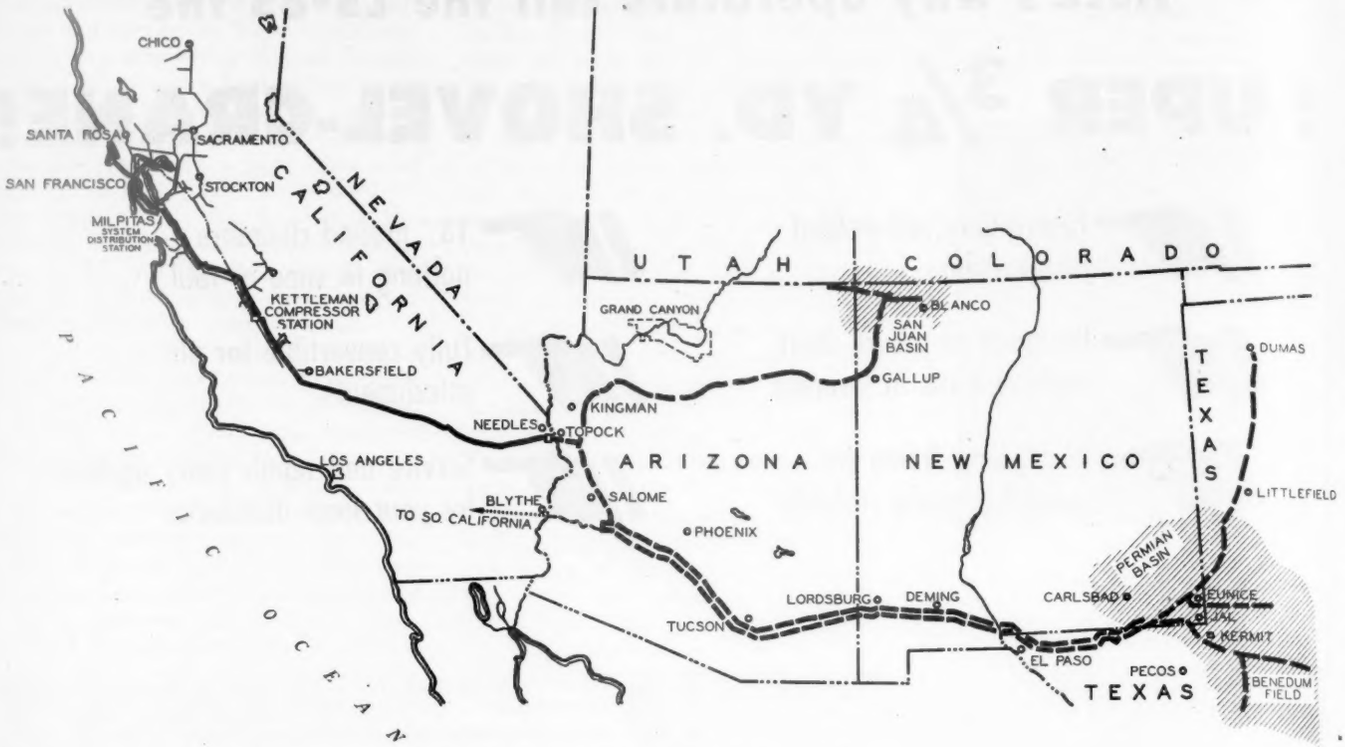


Pacific Gas and Electric Company pipe line and feeder lines. The P.G. and E. line is indicated by the solid line and the others by broken lines.

one that had first been worked out by Bechtel for the Trans-Arabian line. Whereas in Arabia the triple-jointing was entirely automatic, at Santa Clara, Barstow, and finally at Coalinga, the operation was carried out partly by hand and partly by machine. In either case, it cut down by as much as two-thirds the amount of manual welding that would have to be done along the right-of-way. First aligned by an automatic internal clamp while the stringer bead and hot pass were applied by hand, the pipe was rolled and shunted under the heads of the union-melt machines that deposited the bulk of the metal. The finished welds were of the highest quality from the standpoint of metallurgical composition and physical penetration.

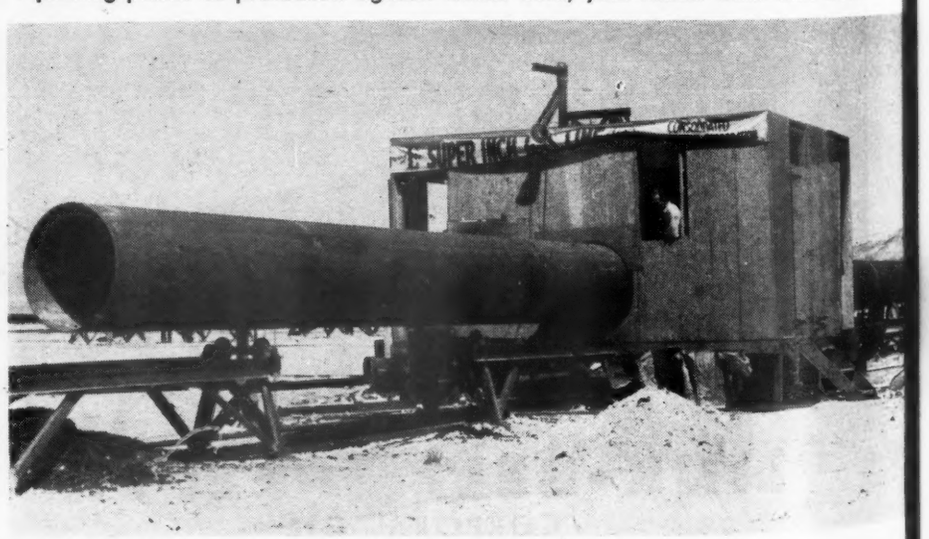
Gamma-ray inspection was given the welds both at the plant and along the right-of-way. A small capsule containing uranium salt was propelled to the center of each weld to be examined. Film was wrapped around the center surface of the pipe and the exposure was made in from 15 to 35 min, depending on the thickness of the steel and distance between the capsule and the pipe.

Before the end of March, 1950, more than 100 miles of pipe had been laid by the main spread out of Topock, in whose best day 21,700 ft were completed. Lowering in was often done before dawn under a battery of floodlights to avoid the expansion that would be caused by the hot sun. This insured adequate slack in the line.

With operations sometimes extending as far as 30 miles from the head end to the backfilled trench, coordination of all the complex steps was constantly maintained through the use of radiotelephones. All passenger cars and pick-up trucks driven by the general superintendent and his supervisory staff were equipped with transmitting and receiving sets, which were in touch with each other and the mobile field offices. Thus, it was always known just who was doing what and where, and orders could at once be given and acted upon.

In addition, an airplane was regularly employed by the constructors from the very outset. Engineers and pipe line superintendents went aloft to study difficult portions of the route, to determine in advance how best to deal with them. On frequent occasions

Shacks were placed around automatic welding machines at field triple-jointing plants as protection against winter cold, year-round wind and dust.



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Photographed along the right-of-way: S. D. Bechtel, Jr., assistant superintendent; William Hanna, superintendent; V. G. Hindmarsh, vice president, Bechtel; S. D. Bechtel, president and board chairman, Bechtel.

landings were made on fields near which the pipeliners were at work, and busy executives came to the scene to observe progress and help resolve major problems.

During the run across the Mojave Desert an unanticipated situation arose. In the Newberry vicinity about 20 miles east of Barstow, although there were some water wells, the country was generally as dry as a bone, yet when a ditch was opened up water flowed into it from an unknown source. The surface of the ground was encrusted with alkali, but the water rising in the trench was fresh enough to drink. Good news though this may have been to residents, it was just another obstacle for the pipeliners to surmount.

It presented two problems. One was to get rid of the water until the pipe was buried, for otherwise the 34-in. pipe would float out of the trench. The other problem was to give the pipe the extra protection against corrosion it would need if the ground were to be constantly saturated, as appeared likely.

Gasoline pumps were put to work emptying the water from the trench into an adjoining field, which was temporarily turned into a beautiful lake in the midst of the desert. At the same time, the pipe was triple-wrapped. This meant that in addition to the standard coating of hot liquid asphalt bonded with rag felt, coated again with asphalt and finally wrapped up in kraft paper, there had to be an extra application of asphalt and rag felt. This extra wrapping was applied after the first by a special machine riding on rubber rollers over the already double-wrapped pipe.

Probably unique in pipelining, this triple-wrap protection was given to the entire portion of the line crossing the "underground river" of Newberry, a distance of 8700 ft, and some 12 miles more across an adjacent alkali flat. The coating here was of $\frac{3}{8}$-in. thickness as against the usual standard of $\frac{1}{4}$-in.

In curious contrast to this contingency was the crossing of the Mojave River near Barstow, which was perfectly dry. Precautions had to be taken, however, because in a matter of hours it has been known to become a raging flood over-reaching its 500-ft bed.

First the right-of-way was sloped to the river bed by cutting away the bluffs with a 2½-yard dragline. Cuts were as deep as 36 ft and as wide as 100 ft, with the spoil removed by bulldozers. Then for 7800 ft the line was made into a dual system. The 34-in. pipe was led into a header, which fed two 26-in. lines with ½-in. walls. These lessened the probability of any interruption in service. The danger of washing out if the lines

The 34 in. line was triple-wrapped for extra corrosion protection in 13-mile stretch of Mojave Desert where subterranean springs flooded trench.

Line-up crew at work on the "Super Inch" line ascending a heavy grade in the Tehachapi Mountains. Bulldozer at lower end of pipe string is serving as anchor.

were uncovered during a flood was eliminated by concrete weights 2 ft in length mounted 10 ft between centers and weighing nearly 5000 lb when the two halves of each were assembled. Corrosion protection was given to the crossing lines by Somastic coating. At no time during this operation was any water encountered.

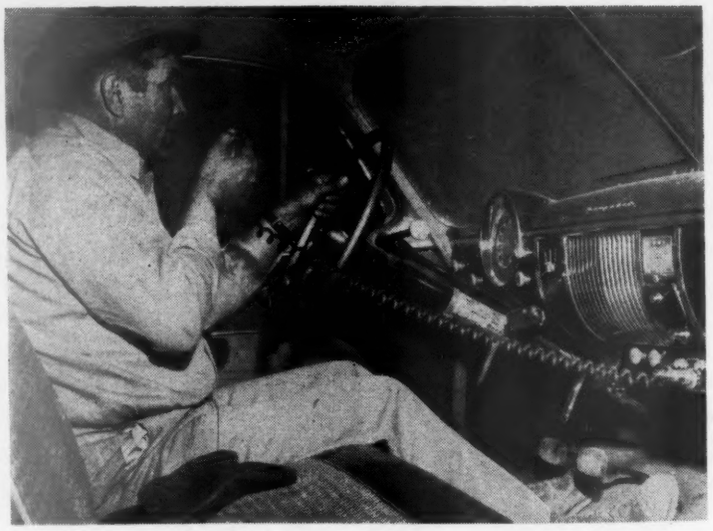
On May 15 dismantling of the Barstow plant began. Two hundred and sixty-two tons of equipment in 15 trailer loads were transported nearly 250 miles and set up again at Coalinga, and within a couple of days triple-jointing was in full swing at the new location.

In the spring and summer the auxiliary spread, having finished its stint in the cotton and potato fields around Bakersfield, was busy in the Tehachapi Mountains. The steepness of the grades in the last 8 miles before the route drops to the San Joaquin Valley precluded the usual over-the-trench wrapping operation and even wrapping in short strings on the level stretches—for the level stretches were too few. Instead, a clean-and-prime, coat-and-wrap plant was set up in a conveniently located small flat area that was found among the mountains. Here, during three weeks in July, some 44,000 ft of 96-ft pipe sections were cleaned, coated, and pre-wrapped. Tightly bound to dollies in groups of three, they were towed by crawler tractors to the right-of-way via a series of "shoo-flies" or access roads bulldozed around the precipitous slopes for the purpose.

The steepest pitch on the whole line was on the west slopes of the Tehachapis, where it was 57 per cent. Ditching was accomplished here with a D-4 dozer winched down from the brow of the hill, while intersecting shoo-flies were cut around the hillside. By this means, short sections of pre-wrapped pipe were carried by side-booms and lowered into position.

In the irrigated land around Arvin and Bakersfield pre-wrapped pipe had already been used. Here it was in

Wrinkle bending machine in action on the pipe line.



R. L. (Bob) Bowman, general construction superintendent.

short lengths so that it could be threaded under concrete water lines, which had been cautiously uncovered to avoid damage, and lining-up and welding were done at the bottom of the ditch. So careful were the pipeliners in traversing farm land that only a few months after they had done their work nearly all traces of the right-of-way had disappeared and vegetation thrived over it as before.

While the auxiliary gang was at work in the Tehachapis, the main spread leap-frogged to the San Joaquin Valley. In one month—August—this outfit chalked up a record by lining up, welding, treating, and lowering in more than 56 miles of pipe.

That month and subsequently, after long sections of the line were finished, they were purged. This was a spectacular procedure when gas, introduced at a pressure of 600 psi was suddenly released, blasting out accumulated dust, dirt, and debris hundreds of feet into the air from an open end. Every 10 miles or so block valves were installed, with blow-down valves in between.

The key to the speed of construction—apart from the skill and enthusiasm of the men on the job—was the specially designed, oversize equipment. The first major innovation in this respect came near the outset of operations when it became apparent that conventional sideboom tractors were too light to handle the 34-in. pipe for the lowering-in operation. In consequence, the inboard track of the heaviest (24-ton) crawler tractor was extended 22 in. to achieve more leverage; and such rebuilt tractors were then able to juggle pipe loads weighing up to 80,000 lb without toppling. Welded, cleaned, coated, and wrapped sections as long as 4500 ft were thus picked up and lowered in by five to nine sidebooms working in unison (the number varied with local conditions). In this way, up to 9000 ft of pipe were lowered in daily.

Also in the "largest-ever-built" class were two self-propelled cleaning-and-priming machines each weighing 7000 lb; two self-propelled coat-and-wrap machines each weighing 12,000 lb, and two bending machines, the latter being particularly in demand in the Tehachapi Mountains and the Panoche Hills, where the number of bends averaged 41 per mile.

Another special piece of equipment—this one being in the smallest-built class—was a tractor with a 42-in. blade, that crawled into the trench dug by the big machines. Dubbed "the doodlebug", it obviated hand work, its function being to smooth the floor of the trench and cushion it to receive the pipe.

Still another piece of "equipment" that played an important part and tickled the fancy of onlookers was the lowly old-fashioned feather duster. Between the clean-and-prime machine and the coat-and-wrap machine walked pairs of men each wielding a feather duster. They brushed off any dust that had accumulated, thus insuring proper bonding of the asphalt and wrapping material, and at the same time inspected the surface of the pipe for any spots left un-

This is the "Doodlebug," a tractor with a 42-in. blade, smoothing and leveling the floor of the "Super Inch" trench.

The steepest grade on the "Super Inch" right-of-way. This is on the westerly side of the Tehachapi Mountains, where the pitch is 57 per cent. Backfilling is here shown being completed after pipe has been lowered in by equipment working from "shoo-flies."

Setting an intermediate blow-down valve. Block valves were placed about ten miles apart.

treated. One man who had been on the feather-duster detail all the way from Topock, was seen to have tears in his eyes as he flicked the last speck of dust from the pipe at the final tie-in point. Holding his feather duster affectionately, he declared he would take it home as a souvenir.

The construction of access roads was in itself a sizable project. Often they had to be routed around canyons and gullies. The transportation of about 200,000 tons of pipe and supplies was involved, and the hauling contract — undertaken by Miles & Sons—is believed to have been one of the largest in the history of trucking in California. The diesel tractor -and-trailer units were modified to accommodate the exceptional loads. Varying with the wall thickness, a single 30-ft, 34-in. pipe joint weighed 1½ to 2½ tons, and four or five 90-ft sections were carried at a time.

On November 10, 1950, 500 days and nearly 90,000 welds after the job got under way, the original 80-mile increment was tied in to the remainder of the 34-in. line from Topock—over all distance, 501 miles.

On hand to congratulate the pipe gang were S. D. Bechtel, president of Bechtel Corporation; V. G. Hindmarsh, vice president; Ray L. Hamilton and A. J. Orselli; while from P. G. and E. were J. A. Love and A. D. Spratling. General superintendent for Bechtel was R. L. Bowman, assisted by W. B. Hanna, R. R. Cook, Ted Anthony, Fred Yost, N. L. Barron, Walter C. Gee, S. D. Bechtel, Jr., and S. J. Valline. Job engineer was C. F. Myers, and welding engineer was R. G. Rhoades.

While the actual construction of the line was carried out by Bechtel crews, the contract was fulfilled as a joint venture by Bechtel Corporation, as sponsor, with Conyes Construction Corporation, H. C. Price Co., and Morrison-Knudsen.

The natural gas from the West Texas and New Mexico fields reaches Topock at a minimum pressure of 500 psi. With deliveries of 150,000,000 cu ft a day, transmission through the 34-in. pipe can be made without compressors. For the 400,000,000 cu ft a day scheduled in 1952, compressor stations are being built at Topock and at Hinkley, near Barstow, and increased compressor capacity will be installed at Kettleman Hills, with a total capacity of about 45,000 hp. Seven pressure-limiting stations were incorporated in the line. To maintain a high-load factor gas-storage holders are required to equate supply and demand in the distribution system, and seven new storage facilities aggregating 61,000,000 cu ft were built between 1948 and 1950. * * *

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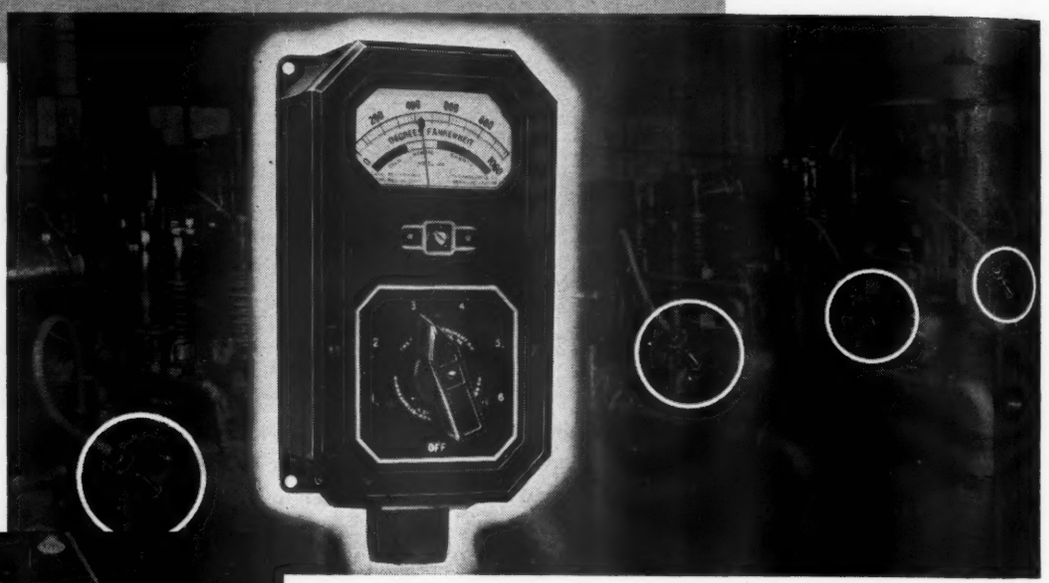

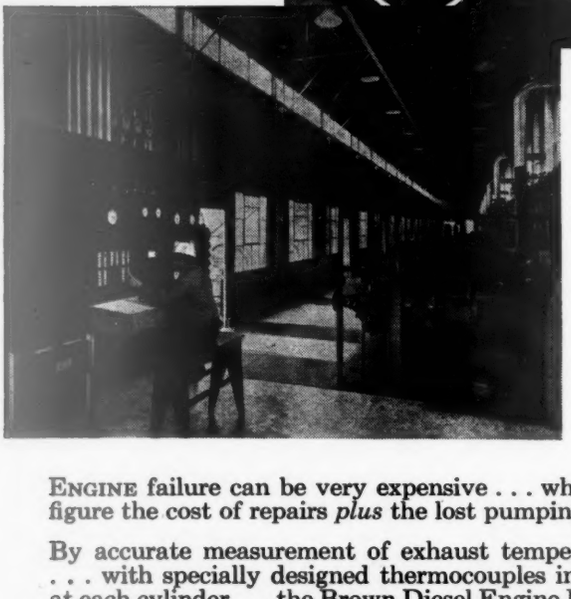

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BROWN INSTRUMENTS

SOUTHERN CALIFORNIA'S GAS PROGRAM

Providing supply for an area experiencing phenomenal population growth has imposed major engineering tasks.

RICHARD SNEDDON*

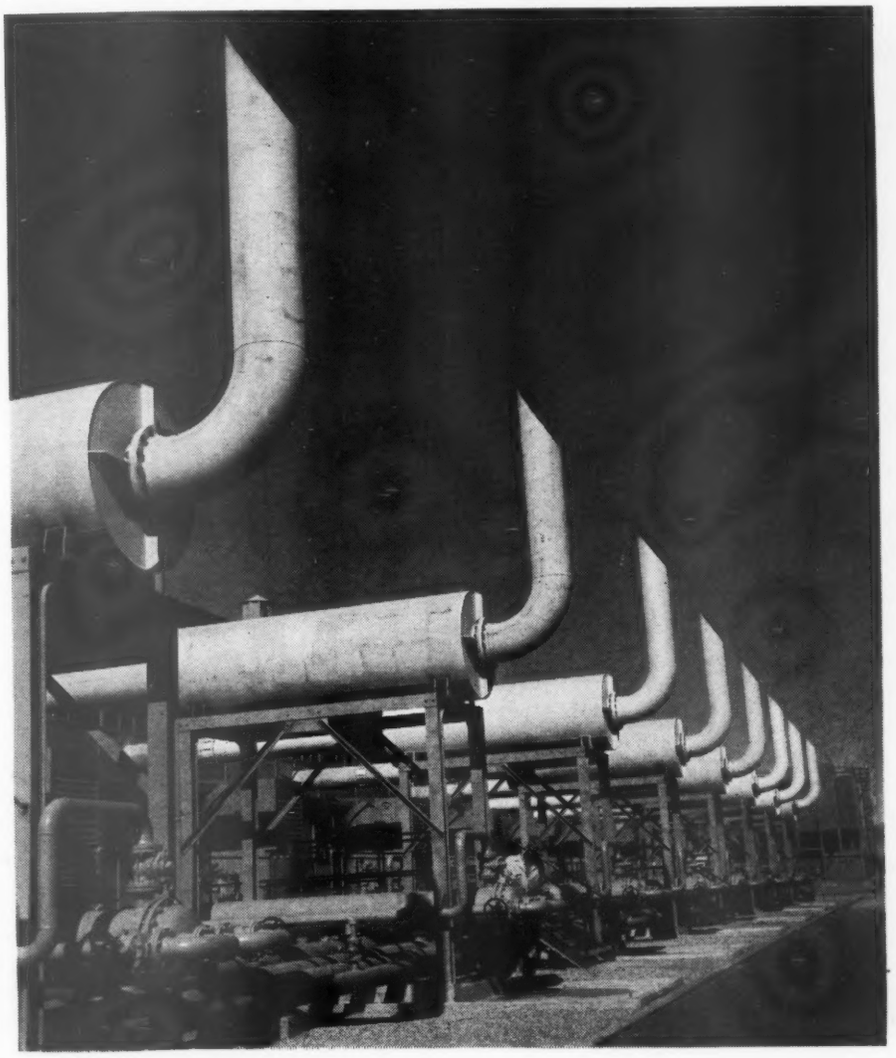
THANKS to the Texas-California gas line, to the La Goleta and Playa del Rey underground storage systems, and to some excellent planning by the California gas companies, Los Angeles recently weathered a peak gas demand of unprecedented proportions without apparently jeopardizing either its present storage status or its future ability to deliver. On March 1, 1951, the Los Angeles basin area alone consumed some 1150 million cubic feet of gas—an all time high. This followed a rather protracted period of cold damp weather that, with brief interruptions, sent the consumption figure soaring higher and higher.

It is interesting to note, by the way, that even in the middle of this rigorous spell, a short return to clear skies and warmer temperatures for just one day resulted in a drop of 214,000,000 cu ft in the 24-hr demand, which shows very plainly the need for a well planned program of operation. It would seem, however, in view of experience to date that despite its rapidly growing industry and population, Southern California has little need to worry about its gas supply. The problem is in good hands.

This, as we have indicated, is due to the completion by a clear-sighted management of the three major projects referred to in the opening paragraph. The cost of these was approximately $43,000,000, which also shows the advantage of permitting industry to build up cash surpluses to take care of ordinary progressive as well as emergency development. In this particular case, the fore-planning and sizable cash expenditures have assured a sufficient supply of gas for all residential and commercial customers in the Southern California area, under the most severe winter conditions. From the big Texas-to-California gas line and the La Goleta and Playa del Rey underground storage systems, a total of about 800,000,000 cu ft of gas a day is available when required to meet peak loads, and this can be amplified by an additional 450,000,000 cu ft obtained from California oil companies. This 1200 million cubic feet of gas can deliver heat energy equivalent to 204,000 bbl of oil, or 753,000 tons of coal, and it would take 24 Hoover Dams to produce a similar amount of electric energy.

Prior to the war, the Southern California gas companies were almost entirely dependent for their supply of gas on local oil operators, but for quite obvious reasons the latter retained control over the rate of production and reserved the right to divert the gas to their own needs any time it became necessary. With the expanding utilization of gas injection to maintain formation pressures, the volume available to the gas companies began to dwindle dangerously, and it was to offset these accumulating shortages that the three-fold plan here dis-

Row of exhaust mufflers at Blythe Station where 10 compressors, with a total of 16,430 hp, handle 405,000,000 cu ft of gas per day.

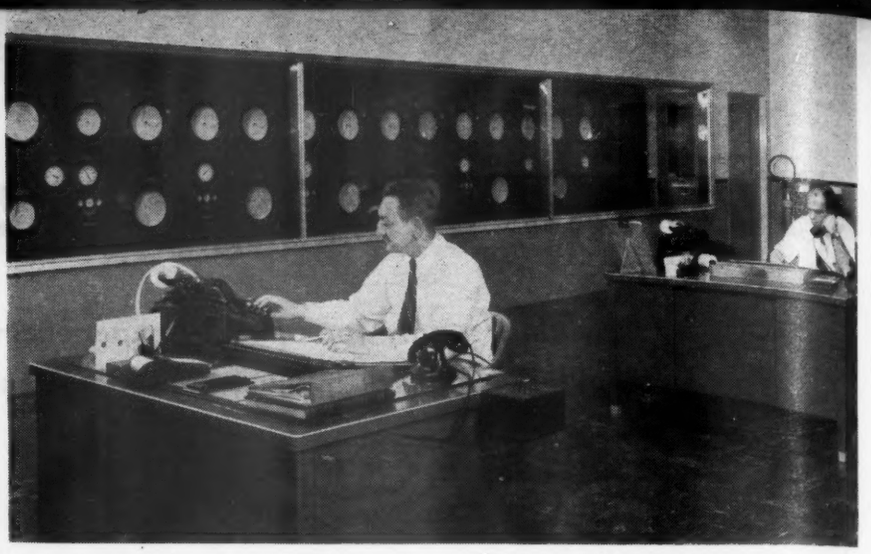


*Pacific Coast editor.

cussed was devised. Its major purpose was (1) to acquire a constant and sufficient supply of gas for the mushrooming population and industry of Southern California, and (2) to acquire full control of this supply.

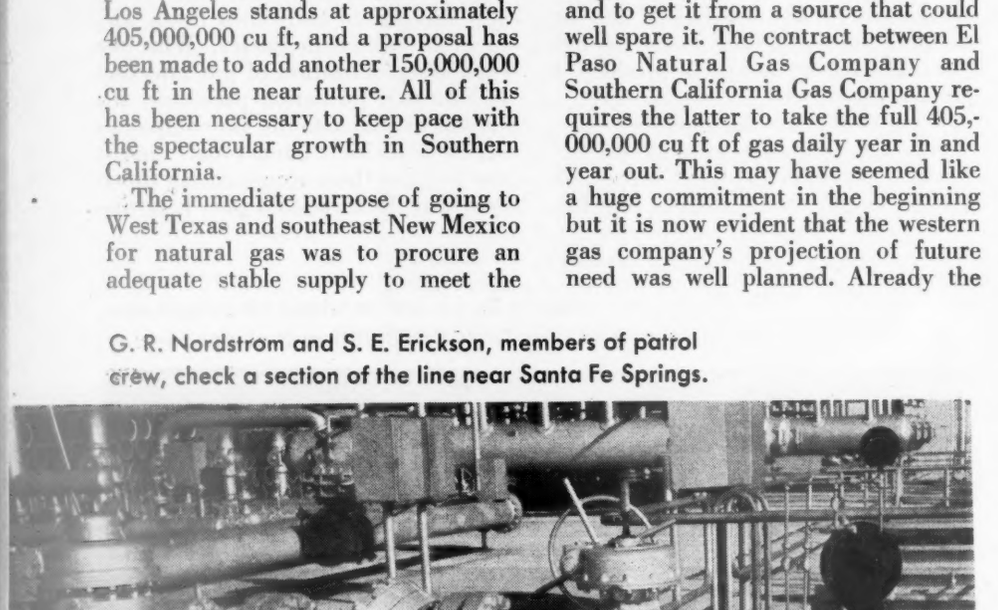
The story of the big gas line built by El Paso Natural Gas Company from Texas to the border of Arizona and California, and the completing span from Blythe to Los Angeles, built by Southern California Gas Company, is already old stuff to the readers of *The Petroleum Engineer*. In any case, gas has been flowing through the 1200-mile line since 1947 and the original committments have been upped from time to time until at the present moment the daily delivery to Los Angeles stands at approximately 405,000,000 cu ft, and a proposal has been made to add another 150,000,000 cu ft in the near future. All of this has been necessary to keep pace with the spectacular growth in Southern California.

The immediate purpose of going to West Texas and southeast New Mexico for natural gas was to procure an adequate stable supply to meet the pyramiding need on the West Coast, and to get it from a source that could well spare it. The contract between El Paso Natural Gas Company and Southern California Gas Company requires the latter to take the full 405,000,000 cu ft of gas daily year in and year out. This may have seemed like a huge commitment in the beginning but it is now evident that the western gas company's projection of future need was well planned. Already the industrial expansion is providing a ready market for the surplus supply during off-peak periods, and the company has further shown its good judgment by making contracts with sundry concerns to receive gas on an interruptible basis. When the winter demand becomes excessively high, these concerns use substitute fuels and on this basis, the cost of natural gas to the industries is competitive with the price of fuel oil.



Spence Street Station, dispatching headquarters of distribution system, is in telemetric contact with all other stations, and exercises control of all movements.

G. R. Nordstrom and S. E. Erickson, members of patrol crew, check a section of the line near Santa Fe Springs.



The western portion of the big 30-in. line extends 214 miles from Blythe to Santa Fe Springs, and a 10-mile 26-in. section reaches from Santa Fe Springs to Spence station in east Los Angeles. From the terminal two feeder lines stretch out: One going into the southwest part of the city will later be connected to transmission lines coming from the north into the metropolitan area; the other runs through Puente and connects through a lateral to the Alhambra-Pasadena district and to the growingly popular San Gabriel Valley. When these feeder systems have been fully completed, the entire city of Los Angeles will be circled by a great loop that will tremendously facilitate the process of distribution.

As the contract was originally drafted, it called for delivery to Southern California Gas Company of 125,000,000 cu ft a day for the first year; 175,000,000 cu ft a day for the second, third, and fourth years; and 305,000,000 cu ft a day thereafter. But growth was even more rapid than was anticipated, demand increased correspondingly, and the program had to be accelerated and enlarged. At the same time, with the mounting receipts, facilities had to be increased. An 82 mile, 30-in. loop line was in-

stalled approximately parallel to the original line west of Whitewater and the compressor capacity at Blythe was considerably augmented. The result of these additions and modifications is that daily receipts in California are 100,000,000 cu ft greater than was called for by the original contract.

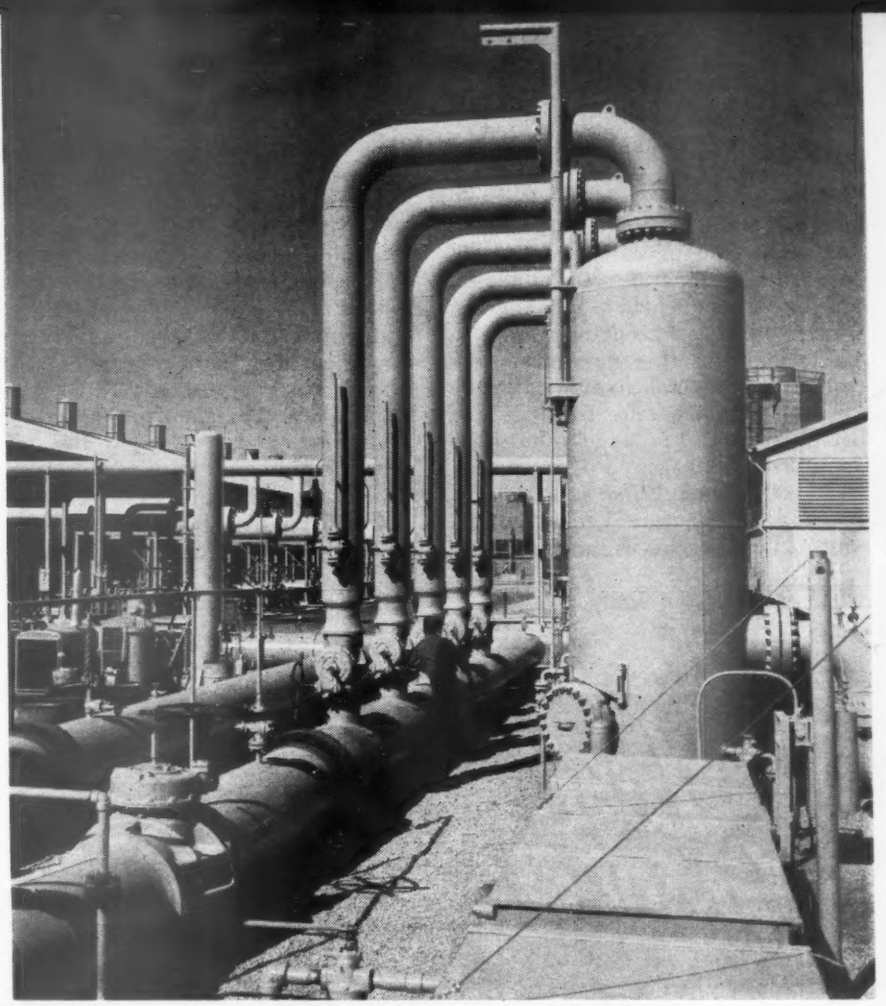
Along the California section of the line are four stations, as follows: Blythe compressor station, Indio division headquarters, Beaumont station, and Brea-Olinda. The gas as it is first received at Blythe, in one of the largest and most modern plants of its kind, is recompressed. There are ten compressors* here, with a total horsepower of 16,430, capable of handling the full 405,000,000 cu ft of gas, and still having enough standby capacity for shut downs and emergency situations. This plant is completely self-sufficient, operating its own water wells, electric generating system for power and light, water softening facilities, a central refrigerating system for cooling the nine cottages built by the company for plant personnel, a swimming pool, and last, but by no means least, an outdoor barbecue. The Indio station is headquarters of the division manager and his staff, and the Beaumont station is a warehouse and garage for the use of linewalkers and maintenance men.

The Brea-Olinda station, just 10 miles from the western end of the 30-in. line at Santa Fe Springs, is a pressure limiting station with a telemetric control system to the Spence Street dispatching office in Los Angeles. All pipe line division stations are provided with radio high frequency transmitting and receiving instruments to permit intercommunication between patrol and maintenance crews and their respective headquarters. This is believed to be one of the most modern communication installations employed by any utility company.

It might be pointed out that the use of the La Goleta dry gas field for underground storage is a development of importance almost equalling that of the big line itself. At La Goleta, which lies a short distance north of Santa Barbara on the Pacific Coast, there is a considerable supply of natural gas and a huge underground reservoir that is ideal for storing surplus gas to take care of the high winter demands. This tightly sealed subterranean structure has a total capacity of about 50 billion cubic feet and gas can be contained in it at a pressure of 2000 psi, at which pressure its volume is only one-hundredth of what it would be at atmospheric.

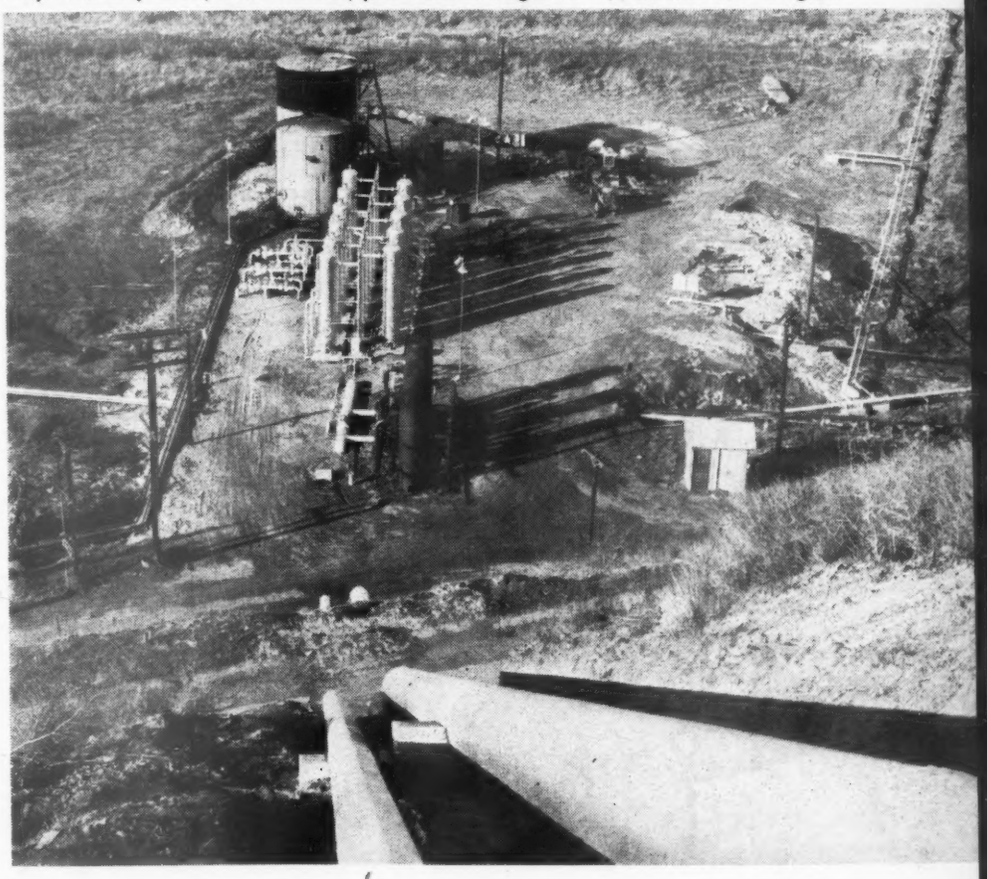
At present, 275,000,000 cu ft of gas a day can be delivered from La Goleta,

*Clark Brothers.



Blythe Station at Arizona-California border, near Colorado River, receives Texas and New Mexico gas and gives it an oil bath to remove pipe scale, rust, and dust collected on the way.

Playa del Rey area, near Venice, provides storage for 1¼ billion cu ft of gas.



but it is planned to increase that amount to 365,000,000 cu ft this year by the installation of two additional 20-mile sections of 22-in. line that will be tied into existing transmission lines. These loops subsequently will be part of a separate 20 and 22-in. pipe line from the field to Los Angeles, which will boost the delivery rate to 475,000,000 cu ft a day. It is estimated that the total investment in the La Goleta plant and facilities for bringing gas to Los Angeles has been about $16,000,000.

The other underground reservoir at Playa del Rey, near Venice, to the west of Los Angeles, is much smaller. Its estimated storage capacity is about 1¼ billion cubic feet, but it is nonetheless infinitely larger than the biggest known artificial holder, and has the distinct advantage of being about 90 miles closer to the Los Angeles metropolitan area than the Goleta reservoir. Gas can be injected here at rates up to 20,000,000 cu ft a day, and with existing facilities can be withdrawn at a rate of about 120,000,000 cu ft a day. The plant is connected to the distribution system by two pipe lines, a 16-in. and a 12-in. Investment in storage and withdrawal facilities is estimated at $750,000.

Spence station is the gas dispatching and coordinating headquarters of the western area. It is equipped with one of the largest metering and regulating systems in California and was designed to handle a maximum of 18,000,000 cu ft of gas per hour. Gas from the main line reaches this station at 450 psi. After the first stage of regulation the pressure is reduced to 250 psi, the load usually carried on the main station header. Through the header the gas is regulated into 4 major trunk supply lines by means of several banks of 12-in. and 16-in. meter tubes, and thence into a smaller distribution main through a single 6-in. tube.

One bank of four 16-in. meter tubes measures gas into the 26-in. north line, which serves as a header between Spence station and Pacific Lighting Corporation's Glendale station. The latter is the terminus of a 26-in. line from the San Joaquin Valley. Another bank of two 12-in. and one 16-in. meter tubes measures gas into a 16-in. line that runs west to Central station and from there fans out to the west and south. From this station downtown Los Angeles receives its major supply. Still another 12-in. meter tube discharges into a 16-in. trunk line that is the main supply artery for the highly industrialized east Los Angeles section. By means of interconnecting headers, the effluent from the various banks of meter tubes can be rerouted in almost any desired manner and the entire station may, indeed, be bypassed should the need arise for any such contingency, in which case the discharge into the various outgoing lines can be manually controlled.

This whole project from beginning to end has been carefully contrived to provide an adequate supply of gas, not only as of now but well into the future, for a section of the country that is experiencing a phenomenal population influx. It would be a comparatively simple matter to provide for a static population, but here we have, in addition to normal growth, a tremendous, unprecedented mass absorption of people from other states. This is attracting new industries and creating others at a quite unpredictable rate. To succeed in the face of these economic difficulties would be success enough, but the process has posed major engineering tasks that have also had to be overcome. In all its aspects this huge venture is the type of industrialism that could be successfully carried on only by a "big" institution. Bigness that brings such tangible benefits to so many cannot after all be such a dire threat to social welfare as the soap-box orators contend.

* * *

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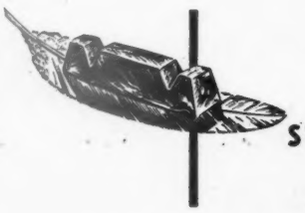

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The lower photo illustrates a popular "Pipeliner Junior" at work on a section of the 1,000 mile Mid-Valley pipeline built by the Britton Contracting Co., purchasers of 6 Lorains. Notice how the "Pipeliner" with its extra-wide crawler straddles the ditch, digs straight ditches as it moves along the right-of-way. Lorain Pipeliners are available in "Junior" (¾-yd. class) and "Senior" (1-yd. class) models with many special features built-in to meet the demands of the toughest pipeline construction.

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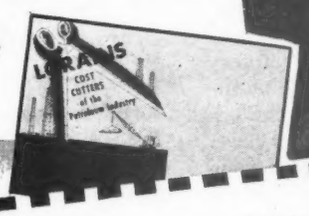

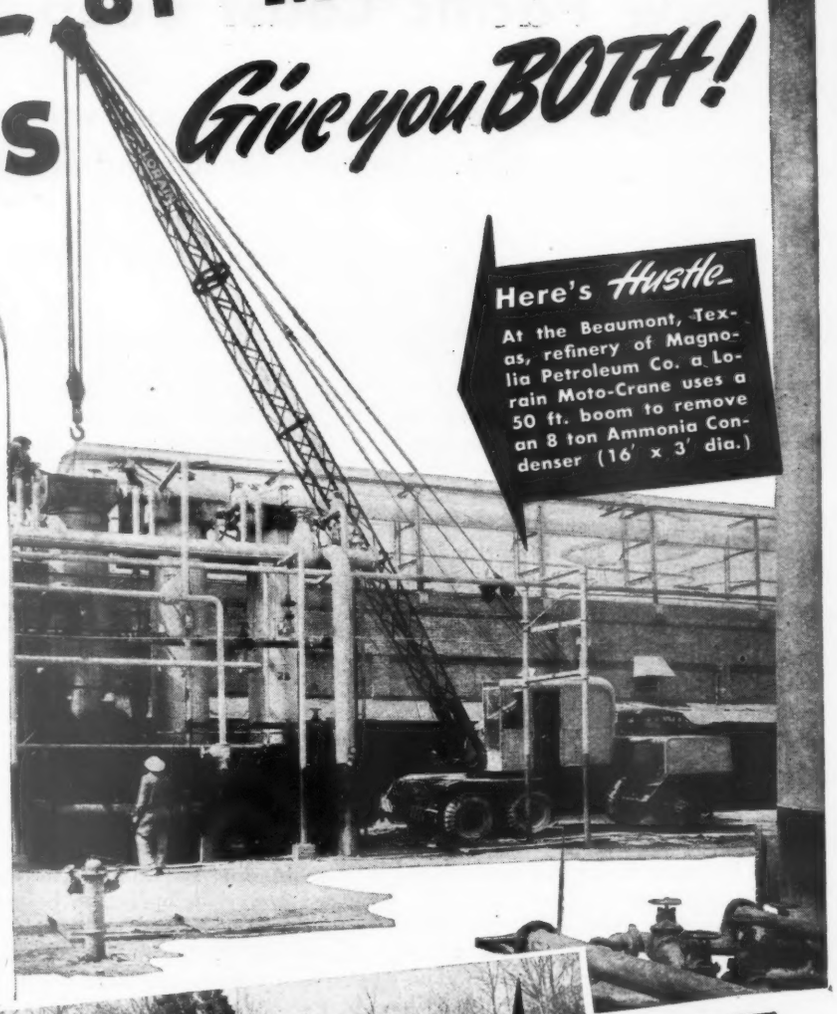

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ALLAN LACEY PIPER

DURING December 1950, Tide Water Associated Oil Company completed the first component of a new California deep water marine terminal at its Gaviota property, Santa Barbara County, with the successful launching of dual 12-in. submarine tanker loading lines extending 2400 ft to sea from the plant site and completion of heavy duty off-shore mooring facilities for ocean-going tankers.

The terminal facilities, now under construction, are designed to handle heavy crude oil production developed by Tide Water Associated in the Zaca Creek field, some 23 miles inland from the seacoast. Despite formation oil of unusually high viscosity, Tide Water Associated has developed high volume production techniques entailing the injection of a small percentage of light petroleum diluent into the wells at pump level, the resulting blended oil being susceptible to practicable surface handling methods. The terminal facilities are being installed as a link in moving the heavy Zaca crude oil to Tide Water Associated's Avon refinery on San Francisco Bay. It is planned initially to haul the blended crude oil by tank truck from the field to the new terminal where cargo lots will be accumulated for loading aboard tankships destined for Avon refinery. Incoming vessels will bring injection diluent from the refinery to Gaviota, discharging through the submarine lines into terminal shore tankage provided for that purpose. Final diluent movement to the field will be accomplished as backhaul via crude oil tank trucks. The Gaviota installation includes a modern high capacity truck loading and unloading terminal to handle these movements.

It will be recalled that Tide Water Associated pioneered the first major old refinery was at a wharf known to submarine line installation on the Pacific Coast in 1924 with a 3100-ft crude oil line of 10-in. diam at its Ventura terminal. This initial installation proved highly effective and was later expanded to the present dual system operated by Tide Water Associated at that point comprising a 16-in. crude oil line and a 10-in. casinghead gasoline line, both of about the same length as the original.

The new installation at Gaviota is Tide Water Associated's third submarine loading line on the Pacific Coast, another 16-in. line having been installed at its Monterey Marine Terminal a few years after completion of the pioneer Ventura project. A key feature in the successful and efficient operation of these installations lay in the early development of specialized super-heavy duty flexible hose to stand the rigorous service conditions.

Old timers in the Gaviota area will recall also that the new terminal is being constructed on the site of one of the first petroleum refineries and vessel loading terminals on the Pacific Coast placed in operation before the turn of the century by the Alcatraz Asphalt Company, a Tide Water Associated predecessor. The early plant was also the seaboard terminus of one of the earliest long distance pipe lines on the Pacific Coast, a 4-in. line extending approximately 30 miles from asphalt mines in the Rancho Sisquoc area of Santa Barbara County. Asphalt was conveyed via the old pipe line in solution with a light petroleum distillate, which was reverse pumped from the refinery to the asphalt workings, blended with native asphalt and ultimately recovered in old refinery stills for re-use. Vessel loading at the early coastwise marine trade as Alcatraz Landing.

The modern terminal construction now underway will actually be the third plant venture to be operated on the site. Intervening between the early asphalt facilities and the present project, a second refinery and terminal was constructed in the years between 1915 and 1920 serving as the terminus for an 8-in. pipe line system originating in the old Casmalia oil field of Santa Barbara County. After many years of operation this pipe line and the terminal steel tankage, still in surprisingly good condition, were salvaged and re-utilized at other points in the company's operations during the steel shortage of World War II.

The new dual submarine lines are constructed of seamless 12¾-in. OD, 65.42-lb, line pipe protected full length with a corrosion inhibiting coating. Prime contract on the line installation was with Hood Construction Company who handled all shore work. Smith Rice Company sub-contracted the off-shore work, utilizing a diesel-electric salvage barge for pulling the lines into sea position from the shore launching ways, placing the mooring anchors and buoys into position, and installing the tanker loading hose at the seaward end of the lines. The launching ways utilized steel slide rails with double timber slide skids to support both lines for the simultaneous launching.

The seaward ends of the two lines are cross connected with heavy return bend fittings incorporating a head outlet flange to which the single vessel loading hose is connected. This design, together with appropriate shore manifolding, will permit flushing high viscosity crude oils from the submerged loading line by means of

The Author

Allan Lacey Piper joined the pipe line department of Tide Water Associated Oil Company in 1937 as engineering estimator in the San Joaquin Valley operations shortly after graduation from the University of California at Berkeley where he received his degree in mechanical engineering. Piper subsequently worked on various field engineering and construction assignments in Valley and Southern California areas. Since 1944 he has been engaged as transportation department engineer at Tide Water Associated Oil Company's general offices in San Francisco.

EXCLUSIVE

AUTOMATIC TOTALIZING of GAS FLOWS

pneumatic integrator accurately follows even rapidly varying flows

the counter reads directly in cubic feet—or other desired units.

★ *saves time and cost of planimetering*
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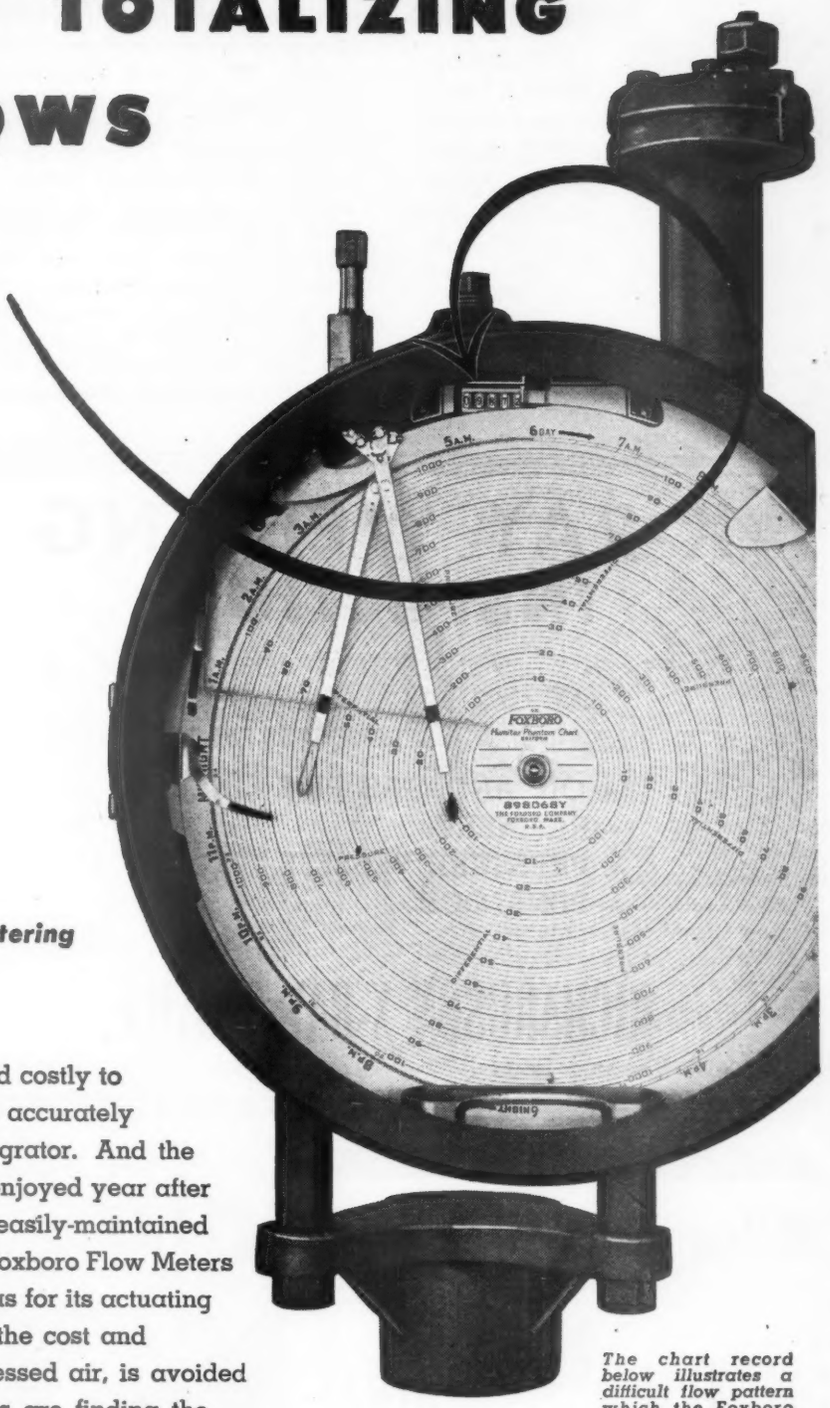
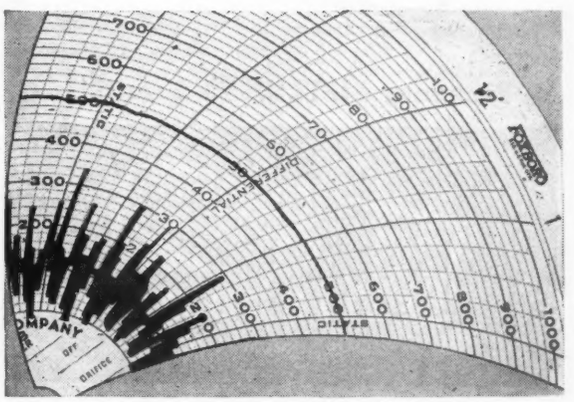


The chart record below illustrates a difficult flow pattern which the Foxboro Pneumatic Integrator is successfully totalizing.



Even rapidly varying flows, so difficult and costly to integrate manually with a planimeter, are accurately totalized with the Foxboro Pneumatic Integrator. And the savings over "manual" totalizing will be enjoyed year after year, indefinitely. ↑ ↑ ↑ This simple and easily-maintained device, which is available on all types of Foxboro Flow Meters used in the oil fields, utilizes the flowing gas for its actuating power. Thus the hazard of electricity, or the cost and difficulty of providing a supply of compressed air, is avoided altogether. ↑ ↑ ↑ Many oil field operators are finding the Foxboro Pneumatic Integrator an ideal solution to their gas flow totalizing problems. It is fully described in Bulletin 394 . . . write for your copy. **The Foxboro Company, 1305 Neponset Avenue, Foxboro, Mass., U. S. A.**

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circulation with terminal pumping equipment. Due to shore side space limitations, each of the two lines was fabricated in three sections of approximately 900 ft each and launching was accomplished in three separate pulls. All electric arc girth welds were X-ray inspected,* following which exterior steel re-inforcing sleeves were welded to each joint. Line launching work was coordinated by barge-to-shore short wave radio, and was assisted by excellent December weather. Water depth at the seaward end of the line is about 58 ft. Approximately 160 ft. of 10-in. loading hose is provided for connection to vessels.

Mooring facilities for holding tankships in position while loading consist of five 16,000-lb Navy type steel anchors, each connected to heavy duty mooring buoys by approximately 65 fathoms of 2¾-in. stud link anchor chain. The mooring pattern provides a stern buoy, two stern quarter breast buoys and two breast buoys that are normally used in conjunction with vessels' bow anchors during loading. Shore aids to navigation of tankers while mooring will include range lights and fog horn with automatic pulse timer.

Site grading work and construction of earthen tank levees were completed during December 1950, and erection of steel tankage began during February, 1951. Completion of the entire job is scheduled for about May, 1951.

The terminal shore facilities incorporate many modern design features. Three 80,000-bbl all-welded API cone roof tanks are provided for crude oil and diluent storage and a 30,000-bbl all welded tank will handle receipt of ballast water from vessels and waste water from field production operations. Re-inforced concrete separator basins and filter chambers are included in the ballast and waste water disposal installation.

Plans include a centrifugal cargo loading pump with 600-hp electric drive having a design loading rate of approximately 7000 bbl per hour. Facilities for heating heavy oil by circulation include a direct fired tubular heater and electrically driven rotary pumps.

Principal oil line valves throughout the entire plant will be equipped for remote push button operation from the pumphouse control board, which also carries pilot lights indicating valve position and operation. The central control board also carries panel instruments for electrically operated remote reading tank gages for the three oil tanks and three-point remote temperature indicators are also provided for each of these tanks. Ship to shore control of cargo loading operations will be maintained by short wave radio, similar to practice at other Tide Water Associated submarine line installations.

An efficient under-cover truck loading and unloading installation is also provided for receipt of blended crude oil from the field and out loading of injection diluent for back-haul to the Zaca Creek field operations.

A group of modern cottages for employee accommodation will complete the plant layout, making for self-contained operation at the relatively remote terminal location.

*Richardson X-Ray Service, Los Angeles.

* * *

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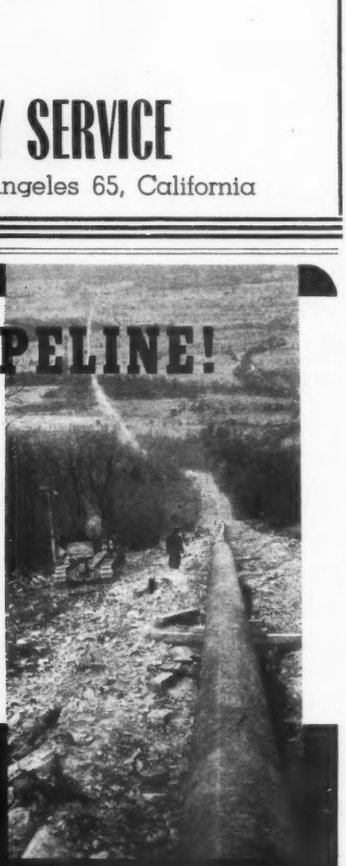

Pioneering PIPELINERS Since 1915

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Designing and Building *SAFETY* Into Large Gas Pipe Lines

They are safe to operate if especially made to transmit high pressure gas over long distances

Beginning pull over the Hackensack River, New Jersey. First 50 ft of pipe line dragged into the river supported by barge.

STANLEY OWENS

A PROPERLY designed and well constructed large diameter natural gas pipe line system is safe to operate. This is proved by the record of continuity of service of those lines *especially designed and built for the purpose of transmitting high pressure gas over long distances.* With a record of practically 100 per cent of continuity of service behind them, these lines have reduced to a minimum the possibility of breakdowns or ruptures. This has been accomplished through careful attention to the design and method of construction from a *safety standpoint.*

Transcontinental's natural gas pipe line extends 1840 miles from Mercedes, Texas, to 134th Street, New York City. Including sales and purchase laterals, the system contains a total of 2330 miles.

It is modernly engineered and especially designed to carry natural gas. The major portion of the line is 30 in. in diam. The pipe is welded steel of a special formula to provide extra strength.

Compressor stations, eventually numbering 20, will maintain the pressure and provide a maximum volume. The present plans provide for a capacity of 555,000,000 cu ft a day.

It is interesting to note that because of the huge storage capacity effect of a line 30 in. in diam and over 1800 miles in length, a shut down at any one point along the line for repair work very seldom means any interruption of the flow of gas to the customer.

From their inception, natural gas pipe lines are designed and engineered for continuity of service. Attention to safety begins in the steel mills where the special alloy steels have been developed for pipe fabrication.

We outline the various steps at each of which safety is the major consideration; from the manufacture of the steel in the pipe to the delivery of gas through the completed pipe line:

Pipe Manufacture

A ladle analysis was made on each heat of steel at the mill. Only plates from those heats conforming to the contract ladle analysis were used.

Plate Specifications (Kaiser)

Chemical composition:

Carbon	0.20 to 0.28
Phosphorus	0.04 max.
Silicate	0.12 max.
Manganese	0.80 to 1.10
Sulfur	0.05 max.
Copper	0.20 max.
Nickel, chromium, and molybdenum; total of the three elements	0.20

Tensile tests also were conducted on specimens cut from one length of finished pipe made from a plate selected from each heat of steel. One transverse tensile test was made on a specimen cut from a finished pipe across the weld with the weld in the center of the specimen, to determine the ultimate strength of the weld.

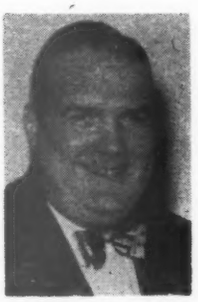
Another transverse tensile test was made on a specimen cut from the same pipe but 90 deg from the weld to determine the ultimate strength and the elongation of the steel.

After the rolling of the plate a physical inspection was made for gage, flaws, and defects.

The pipe was then double-welded by a submerged arc fusion welding process (both internally and externally). Each weld was inspected, both on the outside and inside at the mill. In addition, an X-ray control was used in the welding procedure at the mill.

Each length of pipe was then placed

The Author



Stanley Owens, director of safety, Transcontinental Gas Pipe Line Corporation, holder of a BS degree in electrical engineering from Armour Institute of Technology, has had a wide experience in creating and maintaining safety organizations and insurance programs in public utilities and industrial plants. Shortly after Pearl Harbor he was appointed a member of the War Training Staff of the Illinois Institute of Technology. Subsequently, during World War II, he was regional security officer of the Facility Security Division of the Federal Government. He has had seven years' experience in casualty engineering, handling all types of casualty insurance engineering, setting up and maintaining plant safety organizations, etc. For three years he was resident and then chief engineer of heavy underground tunnel projects driven under air pressure. An interesting job was the demolishing of the 60-year old train shed of the La Salle Street railroad station in Chicago and erection of a new concrete structure. He was in charge of all safety operations on this project. He is a member of the AIEE, American Society of Safety Engineers, Houston Engineers Club, Veterans of Safety, and Pipe Liners Club of Houston.

EXCLUSIVE

Automatic welding machine speeds jointing operation as 350-ft sections of pipe are assembled for Hudson River crossing. Pipe was covered with Somastic coating.

in a retaining die and subjected to an internal hydrostatic pressure to increase the initial yield point and expand the pipe to the specified outside diameter. Comparative tensile tests showed that the yield strength of the steel was increased by 12,000 to 20,000 psi by the internal expanding or cold working operation.

Following the expanding operation, and with the same equipment, the retaining die was removed and a specified hydrostatic pressure test made. Each length was tested to a hydrostatic pressure that will produce a stress of 90 per cent of the actual transverse yield strength as determined for each particular heat. The pressure test varied according to the thickness and the diameter of the pipe. On 30-in. by 0.3125-in. size pipe, a pressure test of 975 psi was applied. The test pressure was maintained for not less than 10 seconds.

For the determination of the pressure to be applied at the mill on the

In preparation for crossing of Hudson River, 375-ft lengths of 26-in. pipe were assembled at Edgewater, New Jersey.

PHILCO MICROWAVE COMMUNICATIONS SYSTEMS

Among informed pipeliners, it is recognized today that communication via microwaves is proving more reliable than comparable wire line facilities for the transmission of voice, telegraph and remote supervisory control signals. Yet it is important to know, too, that all microwave systems are *not* identical. Only Philco Microwave Systems provide a 2-fold combination of *both* propagation reliability and equipment reliability. The utmost continuity of communications service is thereby assured...with unattended operation 24 hours a day, each day of the year . . . through sleet, snow and wind storms.

PHILCO PROPAGATION RELIABILITY

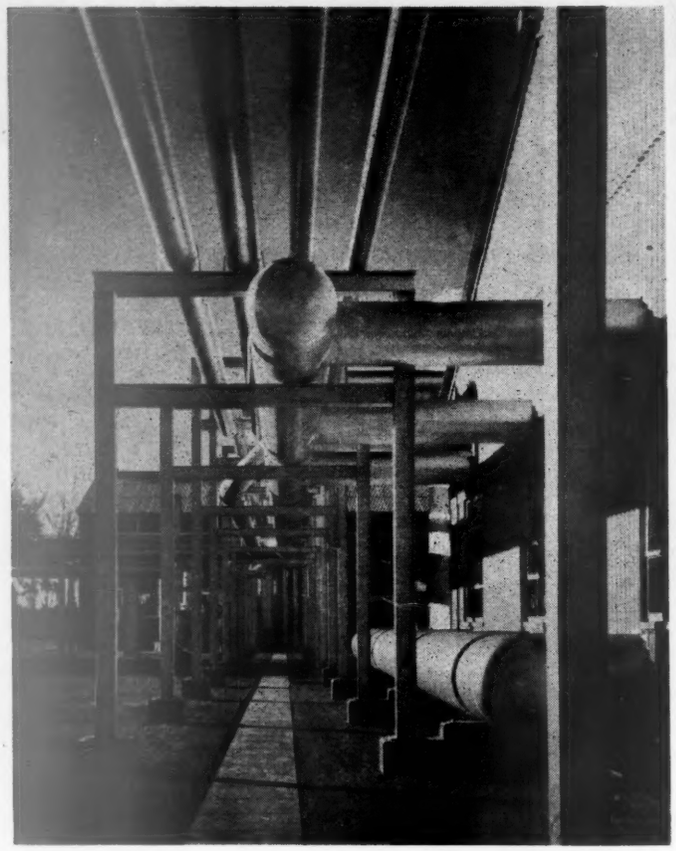
- Philco microwave systems provide a 30 db margin of propagation safety
- This margin of safety assures excellent communications even during brief periods when the received signal may fall 1000 times below its normal strength
- As a result propagation reliability approaches 100% even over long signal paths
- Reason: One full watt of transmitter tube power—plus the super-high antenna gains available in the 6,000-7,000 megacycle frequency range—plus superior FM receiver performance.

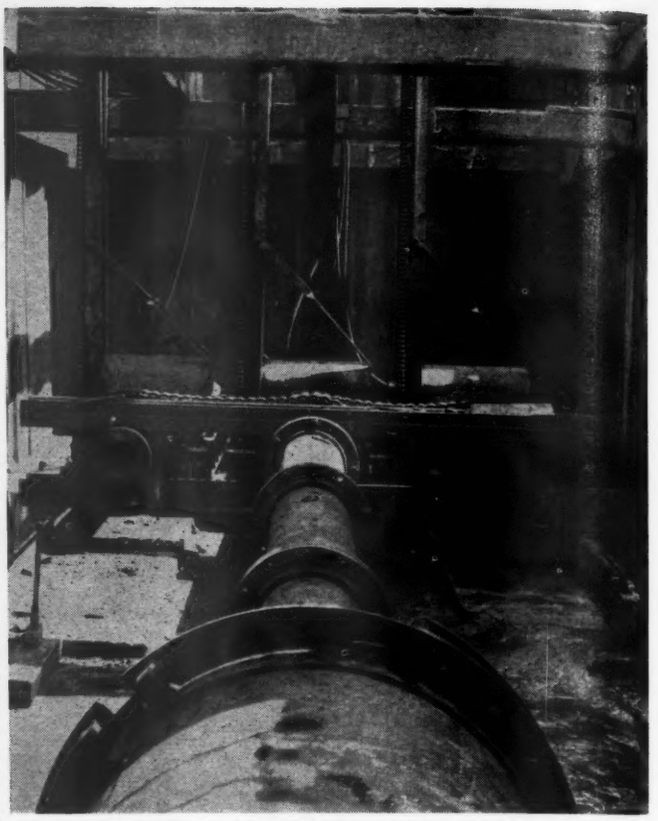
PHILCO EQUIPMENT RELIABILITY

- The straightforward feedback repeater design minimizes the number of tubes and components
- A single klystron type tube with a life expectancy exceeding 10,000 hours is used for both transmission and reception in each direction
- All tubes and components meet JAN specifications where applicable and are operated well below their ratings to assure long life
- Full duplicate microwave equipment (including power supplies) with automatic switchover may be provided where desired.

For further information please address inquiries to:
PHILCO CORP., Industrial Div., Phila. 34, Pa.

View showing part of overhead piping. All piping in Transco compressor stations is above ground, thus assuring immediate accessibility for inspection. This also minimizes corrosion.





Rotary double drive machine boring for 34-in. casing under Pennsylvania railroad in New Jersey.

30-in by 0.3125-in. size pipe we used Barlow's Formula:

$$P = \frac{2 \times t \times S \times 90\%}{D}$$

Where:

P = pressure, psi.
t = wall thickness of pipe, in.
S = minimum yield, psi.
D = outside diameter of pipe, in.

Then, substituting we have:

$$P = \frac{2 \times 0.3125 \times 90\% \times 52000}{30}$$

P = 975 psi.

While under pressure, the pipe length was further tested by being struck 10 blows with 6-lb hammers, each approximately 24 in. apart along the entire length of the longitudinal weld.

Each joint of pipe was then mill inspected for flaws, defects, circumferential tolerance, end finish or bevel, and gage.

Each joint of pipe was then examined by inspectors from an independent firm of engineers, The Moody Engineering Company of Pittsburgh, Pennsylvania. These inspectors examined each joint of pipe both externally and internally and reported their findings to Transcontinental Gas Pipe Line Corporation. They insured confirmation to our specifications.

Pipe Line Construction

Upon arrival at the railhead, the pipe was inspected while being unloaded, for possible damage en route.

A further inspection was made during the double-jointing welding procedure, which was followed on each spread.

When the pipe was strung in the field, each joint was examined for any damage that might have been caused in transit, unloading, stringing, or while stored on the right-of-way.

Before being permitted to weld on the pipe line, all welders had to pass a qualifying test for high pressure electric welding.

All field welding operations were inspected by qualified welding inspectors who had successfully passed all welding tests themselves.

Each welder was equipped with an identifying stencil with which he marked each weld as completed. This identified a welder in the event a weld failed to pass inspection.

Through visual inspection or X-ray determination, a welding inspector had the authority to remove any weld from the pipe line. Such welds were tested and for each that did not test beyond the yield of the steel or otherwise showed imperfections below standards, such as gas pockets, slag inclusions, lack of penetration and for ductility, the identified welder was removed from further welding work on the pipe line.

Frequently test welds were cut from the pipe line and tested to determine the running quality of the field welds. Visual inspection of girth welds was augmented by X-ray photographs. These tests were made by operators employed by independent X-ray engineers.

The type of welding rod selected was designed to fit the metallurgy of the pipe to develop tensile strength and ductility above the physical properties of the parent metal in the pipe line.

Following the welding procedure, the pipe was then cleaned, primed, and coated with a coal tar high melting point enamel impregnated with reinforced glass fiber. The materials used had a high dielectric strength and the finished coating was thoroughly checked with an electronic detector to determine the presence of any "holidays" or voids. Such minor defects were repaired prior to lowering the pipe into the trench.

Because of the extremely corrosive condition of the soil in the New Jer-

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D-109

Workman welds last 60-ft section of pipe line at foot of 134th Street on Hudson River, New York City.

Welding inspector using long-handled mirror to view the inaccessible section of weld.

sey area, it was decided to install there what might be considered the ultimate in coating protection. This was a somastic coating, which is a compound of asphalt, asbestos, and an inert material applied over the entire pipe at an average of 5/8 in. thickness.

This material has a high dielectric strength, which obviated the necessity of examining the pipe in the congested areas through this section.

Studies of soil conditions as well as the presence of strong electric currents guided the installation of cathodic protection equipment. Test leads were installed at intervals of one mile to facilitate frequent checking of the electrolytic conditions being encountered.

Testing

Prior to operation, the completed pipe line was tested in short sections. The testing operations follow:

Removal of all air in the pipe by a complete purging operation during which natural gas, at low pressure, was forced through the section of the line under test.

A pipe line cleaning device was then run through each section. This removed iron oxides, dirt, debris, liquids, or any other foreign bodies that may have entered the line during the construction operations.

Each of the above tests was conducted incrementally in several stages and the section under test was carefully checked and inspected after each stage.

Block or shut-off valves were installed at frequent intervals for the purpose of isolating any particular section of the pipe line. The main line valves are of the plug type, which insure a positive shut-off in a minimum space of time.

Each valve was carefully tested following installation. The valve was then securely locked in its operating position.

The line was tested to a pressure of 50 psi over the maximum operating pressure for a 24-hr period.

During the entire testing procedure persons living along the right-of-way were kept continuously appraised of the testing operations by individual and personal contact with each person or head of a family or group residing or working within a distance of 500 ft on either side of the pipe line.

At no time was a test pressure applied until the "all clear" had been given to the testing crews by the em-

Compressor station discharge header situated aboveground.

OLD . . . Bitumastic Enamel being applied by the "Sling Method."

NEW . . . Bitumastic Enamel being machine-applied.

PIPE-LINE PROTECTION IS *better than ever* WITH BITUMASTIC!

● BITUMASTIC has a remarkable history of corrosion-prevention, dating back nearly 100 years. And 50 years ago, Bitumastic Enamel "came into its own" for pipe-line protection.

But years ago it wasn't easy to apply protective coatings. For example, the "Sling Method" shown in the photograph on the left was used by many pipeliners. One man poured the hot enamel into the sling; two men "see-sawed" the sling up and down. Naturally this manual method was slow and laborious.

It's a different story today. Pipe lines are cleaned, primed, coated and wrapped mechanically. The coating machine, shown in the photograph on the right, applies Bitumastic quickly and evenly. Bitumastic is a better product, too. Improved formulation makes it easier to handle and apply.

Today, thousands of miles of the world's oil and gas pipe lines are effectively protected against corrosion by Bitumastic Enamel. Get the *same* effective protection by specifying Koppers Bitumastic Enamel for your next pipe-line project.

Why Bitumastic Enamels give lasting protection

Processed from a base of coal-tar pitch, they are impervious to moisture . . . chemically resistant to soil elements. They make a tight bond with the pipe . . . do not disintegrate with age . . . maintain continuously high electrical resistance.

KOPPERS BITUMASTIC ENAMELS
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KOPPERS COMPANY, INC., Tar Products Division, Dept. 55IT, Pittsburgh 19, Pa.

ployees responsible for the notification procedure.

Pipe Line Operation

The pipe line system is staffed with maintenance crews situated at frequent intervals along the line. At these locations are stored the equipment, trucks, cranes, hoists, tractors, cutting and welding units, lengths of pipe, fittings, valves, and other materials necessary to maintain the line and to meet any emergency. The duties of the maintenance crews are to maintain the pipe line in a safe and stable operation on a 24-hr basis. Each crew is equipped with mobile radio equipment installed on its trucks, which enables it to be in constant two-way communication with the compressor stations, the central dispatching office in Houston, Texas, and the various patrol planes.

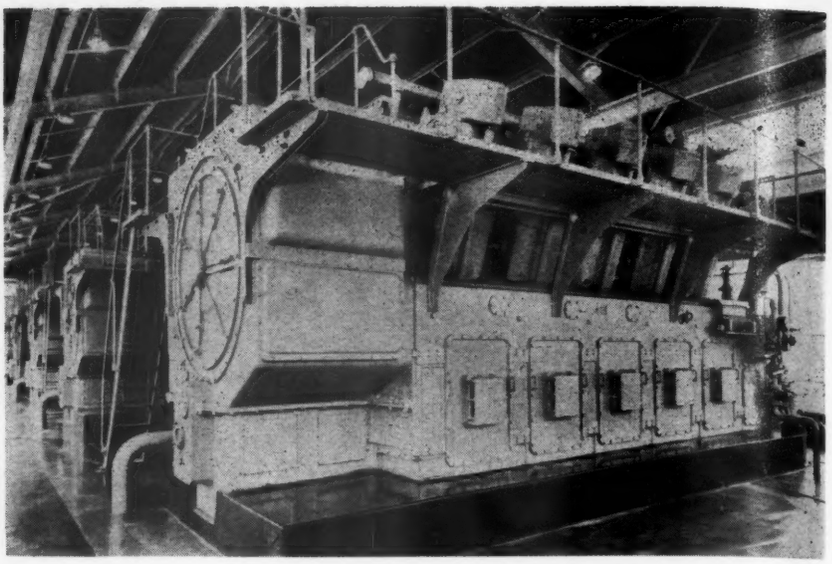
A complete pressure control system is utilized throughout the pipe line system and at no compressor station can the discharge pressure exceed the maximum operating pressure of 800 psi. This pressure is further automatically controlled by the pre-set blow-off or safety valves at each compressor station.

Each compressor station is equipped with an emergency shut-down switch, which enables the entire station to be isolated from the line in a matter of some 47 seconds. The switches are of the fire alarm telegraph type—in other words, a handle projects from the end of the switch and to operate this is turned against a spring tension. The switch, mounted on a pedestal, is situated near the entrance to the parking lot. This is the point at which all employees would normally pass when leaving the station.

In the event of an emergency, it is felt that if the employees were forced to leave the station, the majority of them would normally pass the location of this emergency switch, one of whom would set it in operation.

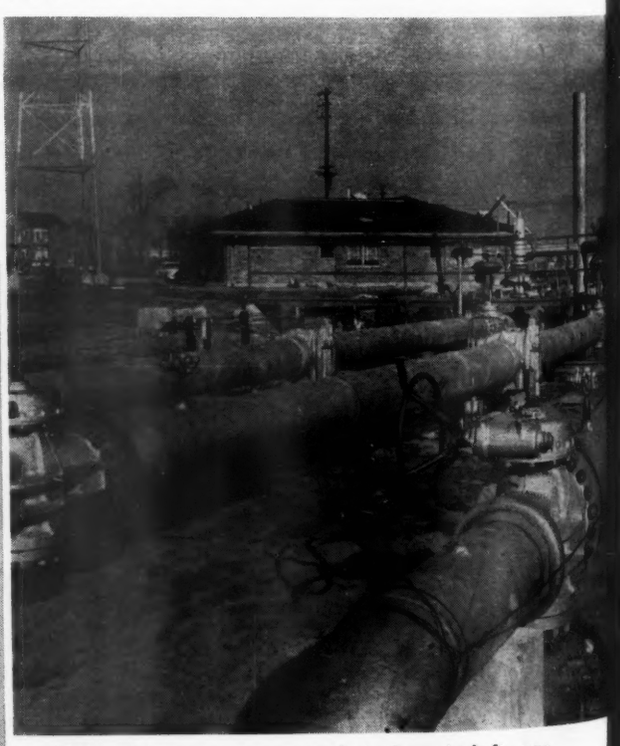
When the handle is turned, it actuates a series of electric contactors.

The first series immediately shuts off the rectox units supplying the power to the ignition on the compressor engines, thus shutting off the flow of gas through the compressors. The next contactor actuates a switch that closes on a circuit supplying power to the electric motor-driven valve mechanism on the side gate suction valve, closing off the intake gas to the station. The next contactor closes a circuit that operates the electric motor-driven discharge valve for the station, closing this valve. The next contactor opens up the main line block valve, which normally is kept closed when the station is in operation. This action effectually by-passes the sta-



Typical guardrails and handrails on elevated platforms and stairways leading to top of over-sized compressors.

As an extra safety measure for the pipe line under the Hudson River, each welded joint had to pass an X-ray inspection test. Here two inspectors study X-ray films of completed welds.



Linden, New Jersey, control station. At left rear is tower for million-dollar micro-wave radio system.

Walkie-talkie radio-telephone communication was used to direct the work on the Hackensack River crossing. Talkers on each bank and on the barge guiding pipe across the stream kept all operations moving smoothly.

tion and allows the main line to flow uninterrupted past the station. The last contactor operates a switch that closes the rectox unit to the auxiliary engine supplying power to the station switchboard, which by this time has served its purpose in supplying power to the valve operators.

Safety Factors

The safety factors of the pipe based on the yield point shown are as follows:

Diameter	Thickness	Safety factor	Yield point psi
800 psi portion of line:			
30 in.	× 0.3125 in. =	1.36	52,000
30 in.	× 0.3250 in. =	1.42	52,000
30 in.	× 0.3750 in. =	1.63	52,000
30 in.	× 0.5000 in. =	1.92	46,000
400 psi portion of line: (North of Linden, New Jersey)			
30 in.	× 0.3750 in. =	3.25	46,000
30 in.	× 0.5000 in. =	4.35	52,000
26 in.	× 0.5000 in. =	5.00	52,000
280 psi portion of line: (Hudson River crossing)			
26 in.	× 1.1250 in. =	11.12	36,000

Determination of the safety factor of the pipe (based on the yield point) for 0.3125 in. pipe at 800 psi operating pressure:

$$Sf = \frac{Pd}{2t} = \frac{800 \times 30}{2 \times .3125} = 38{,}000 \text{ psi}$$

52,000 psi = minimum allowable yield on 0.3125 in. pipe.

$$\frac{52{,}000}{38{,}200} = 1.36 \text{ safety factor (based on the yield point)}$$

The safety factor calculated on a basis of the guaranteed ultimate fiber stress, which, in the case of the 0.3125 in. pipe, is 72,000 psi, will result in a larger figure, i.e., 1.83.

In discussing factors of safety, we must keep in mind that the factors shown above are calculated for the maximum pressure in the line, which exists only at the discharge point into the line. For every mile downstream along the pipe line the factor of safety increases in proportion to the pressure drop encountered as we move along to the next station; where, at the suction side, we will find, due to the reduced pressure, a factor of safety (based on the guaranteed ultimate fiber stress) or 2.73, for 0.3125 in. wall thickness pipe.

Hudson River Crossing

One of the many rivers crossed that proved the most interesting from a construction standpoint was the Hudson.

The work proposed consisted of the laying of a single 26-in. diam by 1⅛-in. wall thickness pipe beneath the river bed. The crossing from Edgewater, New Jersey, to the extension of 134th Street on Manhattan Island, is

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approximately 4700 lineal feet, of which approximately 590 lineal feet is in a space of normally dry land and approximately 4110 lineal feet is in water. The line was required to be laid with a minimum depth of cover of 25 ft in the river bed portion.

When the project was originally anticipated in 1948, the question arose as to how to overcome the bouyancy of a 26-in. diam pipe and whether a negative bouyancy should be obtained by employing a heavier than ordinary thickness pipe or by employing river weights made of either iron or concrete. (In the Passaic, Hackensack, and Hudson Rivers cases, it was deemed more desirable to obtain the negative bouyancy by increasing the wall thickness of the pipe.)

The first operation necessary was to obtain a level area of ground 100 ft in width and approximately 800 ft in length; the 100 ft dimension at approximately right angles to the river bank so as to permit the placing of a 90-lb narrow gage railroad track. At the end of the track was placed a double-jointing automatiq electric welding machine employing two 350-amp welding machines, which were combined to make one unit and to employ a continuous welding rod aided by flux, which would make a weld on the 26-in. diam pipe with 1⅛-in. wall thickness in multiple passes in about 70 minutes.

This machine performed in 70 minutes an operation that normally would require about 3 hours for two manual welders working simultaneuosly on one weld, one welder being on each side of the pipe.

By use of the railroad tracks, the pipe was lengthened by welding on 20-ft sections until a total length of 350 ft was obtained.

After these 350-ft sections were completed, each section was subjected to high pressure air test and if the pressure sustained itself overnight then it was evident that the welding workmanship, as well as the original pipe, had all been fabricated properly and satisfactorily. After the test, each joint was covered with a somastic coating between exposed ends not previously coated. About 12 in. of somastic coating was omitted on each end of the 20-ft pipe lengths so that the heat generated by the welding process did not extend under the somastic coating and destroy the original bond.

When the 350-ft sections were joined together, the joints were covered with somastic so that the entire pipe was completely protected against external erosion or electrolytic action.

Additional tests were made during the process of jointing the pipe and especially after each 350-ft section was completed. This test was made by X-raying all welds to determine the possibility of any defect in the weld employed to join each section. Any defects were corrected by the cutting out of the defect and welding the two ends together.

The 350-ft sections of pipe were welded together as they were pulled out into the trench that had been dredged across the river.

Naturally, both ends were allowed to remain free to permit the necessary slack that was needed in order for the pipe to attain its final normal resting position, which approximates a catenary. After being satisfied that all conditions were as desired, the ends were extended with the New York side being attached to the Manhattan sales meter station terminal and the west end being connected to the pipe installed from the header west of River Street in Edgewater, New Jersey, to the west bank of the Hudson River. * * *

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Taking Corrosion Measurements

Susquehanna electrolysis meter and vacuum tube voltmeter are versatile field instruments in investigation and control work.

FRANCIS RINGER

THE purpose of this article is to explain briefly the Susquehanna electrolysis meter and vacuum tube voltmeter, which have been found by Texas Eastern Transmission Corporation and others to be very versatile as field instruments for use in obtaining various measurements in corrosion investigation and control work on buried pipe, cable, or other structures.

The electrolysis meter was originally designed principally for use in areas where the subsurface structures are exposed to corrosion from stray railway currents. It has been found, however, that the meter has wide application in non-stray current areas when a non-polarizing earth electrode, such as a steel bar, is used for obtaining pipe to soil voltages, and when proper care is taken to obtain correction factors as explained later. Also, when it is used in conjunction with the Susquehanna vacuum tube voltmeter, any type of measurement may be made without the need for correction factors and without regard for the type of earth electrode used.

The meters are not recent developments, as they have been used by engineers in the East for approximately 15 years. This article is being written with the hope that some benefit will be derived by those engineers who have not had the opportunity to become acquainted with them.

Because of the rapidly fluctuating nature of stray railway currents, meters used for taking corrosion measurements in areas where stray currents predominate should have a movement of very short period and should be essentially dead beat. Such an instrument, however, inherently has a comparatively low internal resistance, which means that corrections usually must be made for inaccuracies in readings caused by comparatively high values of meter current.

The circuit for the Susquehanna electrolysis meter was designed by Dr. J. M. Pearson, Sun Oil Company, to provide the desirable damping and short period requirements, ease and accuracy in obtaining required correction factors, and ruggedness for field use. It consists of a 300 ohm per volt Weston Model No. 1 electrolysis voltammeter contained in a sturdy oak case together with three "C" size flashlight batteries and a micarta panel upon which are mounted the necessary components for obtaining correction factors for the various kinds of measurements made.

The Author

Francis W. Ringer was born in Guthrie, Oklahoma, in 1908. He graduated from Oklahoma University in electric engineering. From 1925 to 1938 he served successively as clerk, plant engineer, and dispatcher for the Oklahoma Gas and Electric Company at Oklahoma City. From 1938 to 1943 he worked as power plant engineer and electric engineer for Standard Oil of New Jersey at Aruba, Netherlands West Indies. From 1943 to 1948 he worked as pipe line engineer at Tulsa, Oklahoma, and corrosion engineer at Shreveport, Louisiana, for Interstate Oil Pipe Line Company. In 1948 he joined the measurement department of Texas Eastern Transmission Corporation. He has since served as Eastern Division assistant measurement superintendent with technical supervision over gas measurement and corrosion control activities. Through his efforts a successful corrosion control program is being carried out on the Texas Eastern system in the highly corrosive stray current areas in metropolitan areas of New York and Philadelphia.

The binding posts are mounted on the panel, one common negative, and two positives — one for measuring millivolt drop on a pipe line or cable, and the other for voltage measurements such as pipe to earth or between structures. Maximum ranges are 100 volts and 100 amp, and minimum ranges are 10 mv and 1 amp.

If an IR drop reading is to be made on a pipe line, the leads from the two points one the pipe are connected to the negative terminal and the proper positive terminal. A quarter turn rotary type switch is thrown, which makes the measuring circuit in series with a 1-ohm rheostat, one arm of a 1-ohm wheatstone bridge, and connects the meter across one side of the bridge to serve as the galvanometer. A button, marked "C", is then pushed, which connects the internal batteries across the other side of the bridge. The bridge is balanced first by using the 100-mv range on the meter and turning the rheostat until no meter deflection is noted when the battery button is alternately depressed and released. A find adjustment is obtained by repeating the operation on the 10-mv meter range. Measurements may then be made after the rotary switch is turned to the neutral position.

The result of this operation is that sufficient amount of the rheostat resistance has been added in series with the leads to the pipe line to make the total circuit resistance 1 ohm. A circuit analysis and application of Ohm's Law will show that the correction factor is the sum of the circuit resistance and the meter resistance divided by the meter resistance, which is 1.333 on the 10-mv scale of a 300 ohm per voltmeter, or 1.033 on the 100-mv scale. These operations are easily and quickly performed and result in obtaining readings that the investigator can be sure are valid after the correction factor has been applied.

For measuring IR drop on pipe, cable, or other structure, the use of the electrolysis meter in this manner is invaluable in making certain that good connections to the pipe line have been obtained with probe bars or test leads. When probe bars are used it is sometimes very difficult to obtain good connections when the points on the bars are not fairly sharp and the pipe line has developed a well oxidized surface. In such cases it has happened that pipe-to-ground voltages have been mistaken for IR drops on the line because of the circumstances of high currents on the pipe line and only one bar of the measuring circuit has made good electrical contact with the line. If the bridge in the electrolysis meter cannot be balanced in the manner described, it is an indi-

EXCLUSIVE

cation either that good contact has not been obtained with both bars, an open circuit exists in the leads, or a high resistance joint exists in the measuring section of the line.

When voltage measurements are to be made such as between pipe and earth, between structures, across insulating points, etc., the two leads are connected to the common negative terminal and the second positive terminal. The correction factor is obtained by making use of two additional rotary switches, one marked "Multiplier" with two positions "1" and "10", and one marked "Ground" with two positions "In" and "Out", and two additional push buttons: One marked "B" and one marked "G".

Before the leads are connected to the binding posts, the postoffice type plug of the meter proper is inserted in the one volt position, the "Multiplier" switch is turned to the "10" position, and the "Ground" switch is turned to the "IN" position. After the leads are connected, the 'B" button is pushed and the resulting meter reading is recorded as the open circuit voltage of the internal batteries. The "G" button is then alternately pushed and released, and the readings with the button depressed, and with it released, are noted. The difference between these two readings is divided by the reading obtained by pushing the "B" button to produce the correction factor. The two readings obtained by first depressing and then releasing the "G" button should be taken several times if considerable fluctuations exist in the circuit being measured in order that an accurate difference between the two be obtained. The desired readings are then taken with the "B" and "G" buttons released, the "Ground" switch "In", and the "Multiplier" switch in the "1" or "10" position as required. The correction factor will be the same for either range as the internal resistance is the same with respect to the external circuit.

The purpose of the "Multiplier" switch is to change the range of the meter by a factor of 10 when the meter plug is in the 1 volt position without changing the internal resistance (300 ohms) of the meter. This is accomplished when the switch is in the "10" position by connecting the meter in series with a "T" network of the proper resistance values. When the switch is in the "1" position, the meter is, in effect, connected directly to the circuit being measured.

Operation of the "B" button disconnects the meter from the external circuit and connects it directly to the internal batteries.

With the "C" button depressed, the meter is connected to the external circuit in series with the internal batteries, and with the button released the internal batteries are eliminated, the meter being connected directly to the circuit being measured.

The purpose of the "Ground" switch is to render the "Multiplier" switch and the "B" and "G" buttons inoperative if so desired. When this switch is in the "Out" position, the meter is connected directly to the binding posts and may thus be used as a regular Weston Model No. 1 voltmeter, the range being changed by moving the postoffice plug, in the "out" position of the "ground" switch, correction factors obtained on

Parts list for electrolysis meter

No. of pieces	
1	Box, SPL dwg.—3-74
1	Battery case, SPL dwg.—2-717
1	Meter, Weston, Model 1 electrolysis volt-ammeter
1	Resistor, 2 ohm—1 per cent acc.—Type WW3—lug terminals
1	Resistor, 50 ohm—1 per cent acc.—IRC—Type WW4
3	Resistor, Leeds and Northrop—1.000 + or —0.001 ohm— on No. 293 metal spool
2	Resistor, Rubicon—245.45 ohm — or + 5/100 per cent—on No. 10 spool
1	Resistor, Rubicon—60.61 ohm + or — 1/10 per cent—on No. 10 spool
1	Potentiometer, General Radio—2 ohm—Type 214A—2.5 amp—code word "Ruddy"
3	Switches, DPDT—Yaxley—push button—#2006
3	Switches, DPDT—Yaxley—locking—#760
3	Binding posts, Leeds and Northrop—#19
1	Panel, SPL dwg.—1-67B

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Vacuum tube voltmeter.

Electrolysis meter.

the 1-volt scale cannot be used when the postoffice plug is in any position other than the 1-volt range as the internal resistance of the meter would thereby be changed. Correction factors obtained as explained above are valid only for an internal meter resistance of 300 ohms.

If an instrument having an internal resistance other than 300 ohms per volt is to be connected for measurement, the new correction factor can be calculated from the one obtained as explained above. The resistance of the internal circuit is first found by multiplying the internal resistance of the electrolysis meter (300) by one less than the factor. The new correction factor, then, is the sum of the external resistance and internal resistance of the new meter divided by the internal resistance of the new meter.

The Susquehanna electrolysis meter is not at present being manufactured

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for general sale, thus any prospective user must procure the necessary parts and fabricate his own meter. Cost for parts including the case and engraved micarta panel, but excluding the Model 1 meter, should be approximately $100. Although the circuits used have been patented by the Sun Oil Company as a contribution to the advancement of corrosion control methods, permission for construction and use of the meter has, on occasion, been granted to others without cost.

When making precise potential measurements, the current required for operation of the observing instrument must not be sufficient to change conditions in the circuit being measured. Thus, only extremely small magnitudes of meter current can be tolerated when measuring polarization potentials on small or well-coated submerged or buried structures, the charge on a condenser, etc. The null potentiometer voltmeter is an instrument that can measure potentials without drawing current from the circuit being measured after a balance has been obtained, but because of the comparatively high currents that may flow through the instrument before being balanced, and because this type of instrument cannot be used to measure rapidly fluctuating potentials, a properly designed vacuum tube voltmeter must be used.

The Susquehanna Model No. 1 vacuum tube voltmeter was originally designed by Dr. J. M. Pearson of the Sun Oil Company and modified and developed by the Susquehanna Pipe Line Company corrosion department personnel under the supervision of R. F. Hadley for field use in conjunction with the Weston Model No. 1 voltmeter. Any voltmeter with proper ranges and with an internal resistance of less than 1000 ohms per volt may be used with the vacuum tube circuit but because of the period and damping characteristics, which are considered necessary for accurate electrolysis work, Weston Model No. 1 meter is recommended for this purpose.

Except for the external meter, the instrument is completely self contained in a sturdy oak case with leather carrying strap. All batteries are installed in a separate compartment in the case and are easily accessible for testing and replacement. A 3-stage inverse feed backcircuit is employed with a transconductance of approximately 5 ohms and with excellent non zero drift characteristics. Current input is less than 1×10^{-9} amps, which remains essentially constant over the entire range of measurement.

On the panel are mounted two input binding posts, which are connected to the circuit being measured;

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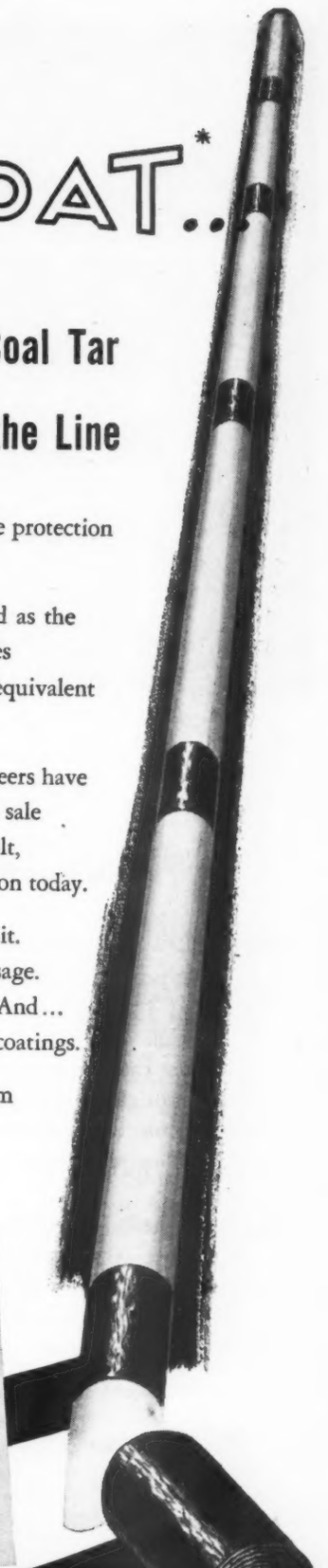

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two output binding posts, which are connected to the meter used for observations; a four position rotary type range switch, one position being used for the 0-.01, 0-.1, and 0-1 volt ranges of the meter, one position for the 0-10 and 0-100 ranges of the meter, and either of the remaining two positions for zero adjustment; a knob that operates a potentiometer used for grid bias control in the first stage for zero adjustment, and a push button type on-off switch. The instrument is not manufactured commercially but may be easily constructed by a competent workman.

List of parts for vacuum tube voltmeter

No. of Pieces	
1	Resistor, 6000 ohm—Ohmite
1	Resistor, 200 ohm URW-023
2	Resistor, 1 meg + or — 1 percent akra—ohm wire wound
1	Resistor, 150,000 ohm + or — 5 per cent—1 watt
1	Resistor, 15,000 ohm + or — 5 per cent—1 watt
1	Resistor, 10,000 ohm + or — 5 per cent—1 watt
1	Resistor, 510,000 ohm + or — 5 per cent—1 watt
3	Condenser, 0.1 micro-farad—400 volt—paper
1	Potentiometer, 20,000 ohm—10-turn Helipot
1	Switch, on-off lp., lt., push button type
1	Switch, 4 position—2 circuit
2	Tubes, 1LY RCA—shielded
1	Tube, 3A4 RCA—shielded
2	Batteries, 30 volt—#413
2	Batteries, 22.5 volt—#412
2	Batteries, 1.5 volt—TE
8	Batteries, 45 volt—#Z3ONX
4	Batteries, 7.5 volt—#5540
4	Batteries, 1.5 volt—4FH

On the Texas Eastern system, the first experience with these meters was during a corrosion survey on a 35 mile, 20-in. high pressure natural gas line terminating in South Philadelphia. This line traverses areas in which the corrosion problems are predominately due to stray railway currents. The use of the meters, and Dr. Pearson's network method of analysis, resulted in obtaining valuable data more accurately and economically than could have been obtained by other known methods.

Since that time the meters have been in constant use on the eastern end of the Texas Eastern system, notably on extensive surveys recently completed in eastern New Jersey and New York City areas. These surveys were conducted in cooperation with operators of other pipe lines, cable, and railway systems. The complexity of the electrical network created by the presence of these various structures, and the extremely wide area covered by stray currents from various railway systems presented problems, the solution of which were greatly simplified by the use of the Susquehanna meter and vacuum tube voltmeter.

Information for this article is being published with the kind permission and assistance of R. F. Hadley, Susquehanna Pipe Line Company, who is well known for his valuable contributions to corrosion control. * * *

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Short Line May Also Present Complex Operations

It isn't only the big transcontinental pipe lines that present challenging problems to the engineers. Sometimes it is almost as difficult to design, construct, and operate a short line through a populous suburban or city area, as it is to snake a super inch across the country. Sometimes, also, the nature of the traffic in which the line is engaged, rather than its size and length, is the thing that adds to the complexity of operation. Take, for example, Standard of California's products line from El Segundo refinery to Culver City. This is a mere 10-mile stretch but it is an interesting one because of the movement involved.

The line was built from 6-in., 18.97-lb, seamless welded pipe, and its function is to move gasoline—two grades—from the refinery to a receiving station adjacent to a rich marketing area. At the refinery end, a short distance from the Pacific Ocean, the line starts off at an elevation of 120 ft, reaches its highest point, 385 ft, in the Inglewood oil field, and drops back to an even 100 ft at Culver City terminal. It crosses the Los Angeles airport where it is installed in a 12-in. casing under the main runways and taxiways, and in general is buried to a depth of 5 ft. North of the airport, the line is in Sepulveda Boulevard (a heavily travelled highway) for 2 miles and thence crosses into Inglewood fields.

At El Segundo, gasoline is pumped into the line by a motor-driven centrifugal pump capable of delivering 185-psi pressure. The line is equipped with two strainers and two meters, and a telemeter instrument transmits the pumping rate in barrels per hour to the Northam office, some 25 miles away. At the Culver City end, a back-pressure regulator holds a pressure of 60 psi against the line. Thereafter the gasoline passes through a filter (hay tank), then through the strainers, and finally to the receiving tanks. Because of the meter set-up, only two receiving tanks are required although two different commodities are being handled. Ordinarily each commodity requires two tanks—one to receive while the other is being delivered from receiving tanks. Trucks are loaded by gravity.

The pressures on either side of the hay tank and the strainer are indicated by differential pressure gages so that the extent to which blocking is taking place is quickly and easily determined. A colorimeter and a gravitometer are employed to indicate the arrival of the new commodity when changing over from one to the other and here, as at El Segundo, the pumping rate in barrels per hours is also transmitted to the Northam station by means of a telemeter. An auxiliary tank is also available for calibration of the meters, the fluid being diverted through a meter into the measuring tank and there being gaged in the usual manner. Calibration of each meter takes place approximately once a month.

In order to prevent the formation of rust in the line, a corrosion inhibitor, consisting of a mixture of caustic soda, sodium nitrite, and water, is injected into the gasoline stream at El Segundo at a rate of 0.5 gal a min. Prior to starting up the line, it was tested with water at 1500 psi pressure. This, of course, caused some rusting to take place and during the first few months of operation, the accumulated rust along with the mill scale in the line was slowly removed by the rust inhibitor and by line scraping. Wire brush scrapers were run through about once a week until there was no longer any trace of rust. The tangible and totally beneficial effect of this was that the flow rate increased from 500 bbl per hour to 535- 540 bbl per hour, which indicates a present "C" value of 160 for the coefficient of roughness.

The last 1½ miles of the line at the Culver City end drops from an elevation of 385 ft to 100 ft. The back pressure regulator, to which reference has already been made, holds this section of the line nearly full when pumping and prevents any run-in from the hillside that would interfere with the accuracy of the shipments versus receipts balance. When changing commodities, the dispatcher notifies the Culver City operator of the approximate time of arrival of the new stock. A few minutes before it is due, thus, the operator takes his stand by the meter set-up and closely observes the colorimeter and gravitometer. When the color and gravity show that the new stream has arrived, it is then switched to the proper tank.

A similar products line to the one described here connects El Segundo refinery with Newmark station, near Montebello. This is an 8-in. line about 23 miles long. It is equipped at the terminals in practically the same way as the Culver City line but is of greater capacity. It was designed for about 1000 bbl an hour, and has been in operation with a new pipe line and metering facilities since 1948. * * *

And Now on the

PLATTE PIPE LINE

Rumsey Brothers will construct 100 miles of 20-inch for Platte Pipe Line Co. from Marysville, Kansas, to a point approaching the Missouri state line near St. Joseph.

We appreciate the distinction of being assigned to one of the big lines—but on any size line Rumsey Brothers combine sound engineering, carefully trained crews, modern equipment, and many years' experience to make certain that the job is done right.

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CONSTRUCTION COMPANY

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New Microwave Relay System

Mid-Valley Pipeline's 1000-mile installation employs carrier frequencies in the 6575-6875-megacycle range

DALE SAMUELSON*

A 1000-MILE multi-channel microwave relay system, extending from Longview, Texas, to Lima, Ohio, has been installed by Motorola, Inc. and is in operation for the Mid-Valley Pipeline Company.

The communications network, jointly owned by the Standard Oil Company of Ohio and the Sun Oil Company, employs carrier frequencies in the 6575-6875 megacycle range and will provide a high level of reliable communications from end to end. Motorola, along with Sohio's C. B. Lester and Sun Oil's Charles Burgess designed the **$800,000 network.**

Microwave relay systems such as this Mid-Valley installation make maximum use of those characteristics peculiar to the higher part of the radio frequency spectrum. Because these frequencies exhibit phenomena similar to those of visible light, diffraction, refraction, and reflection, they can be focused and pointed at a distant object. The relaying of these RF carrier beams upon which are superimposed subchannel signals, results in the formation of a point-to-point radio communications network — a microwave relay system.

Onto the carrier wave of the Mid-Valley system are impressed signals from:

1. Two-voice frequency circuits assigned to party-line dial-telephone.
2. Three-voice frequency circuits assigned to private-line dial-telephones.
3. One party-line teletype circuit, and
4. Two circuits for VHF drop-off communications with Mid-Valley 2-way radio equipped cars and trucks.

Additional circuits are available for future requirements. The network includes 36 repeater stations spaced 14 to 37 miles apart. Starting at the Longview, Texas, terminal, the line runs east to near Haynesville, Louisiana, to Mayersville, Mississippi, northeast to Abbeville, Mississippi; Denver, Tennessee; Clarkson, Kentucky; to near Cincinnati, Ohio, and to Lima as it follows the pipe line. Fig. 1 is a map of the route.

Industrial Applications

Long, cross-country pipe line companies are finding microwave relay systems particularly well-suited for their day-to-day communications requirements. This results primarily from the combination of physical design of pipe lines, and their need for continuous and reliable communications to and from terminal points and between major pumping stations along the route to facilitate safe, even flow of gas or oil.

For those who move liquid fuels by this method, the establishment of a reliable communications network long has been a major consideration. The status of the entire flow, including volume, pressure, and delivery rate, must be known and coordinated from numerous central points. Any desired change of flow must be instigated almost simultaneously from many points. As a result, reliable communications along a line are indispensible.

Railroads and other types of industry are also buying or seriously considering microwave relay for very similar reasons. The Mid-Valley system uses standard Motorola equipment built for general industrial usage.

Microwave Advantages

Microwave relay systems are particularly reliable because of relative freedom from weather problems. Microwave propagation characteristics allow satisfactory systems operation even in the severest weather. The compact microwave relay equipments incorporate highly efficient automatic de-icing facilities to rid the radiation elements of even the heaviest ice formations.

Microwave frequencies are completely free from the effects of static and skip-distance interference. Exten-

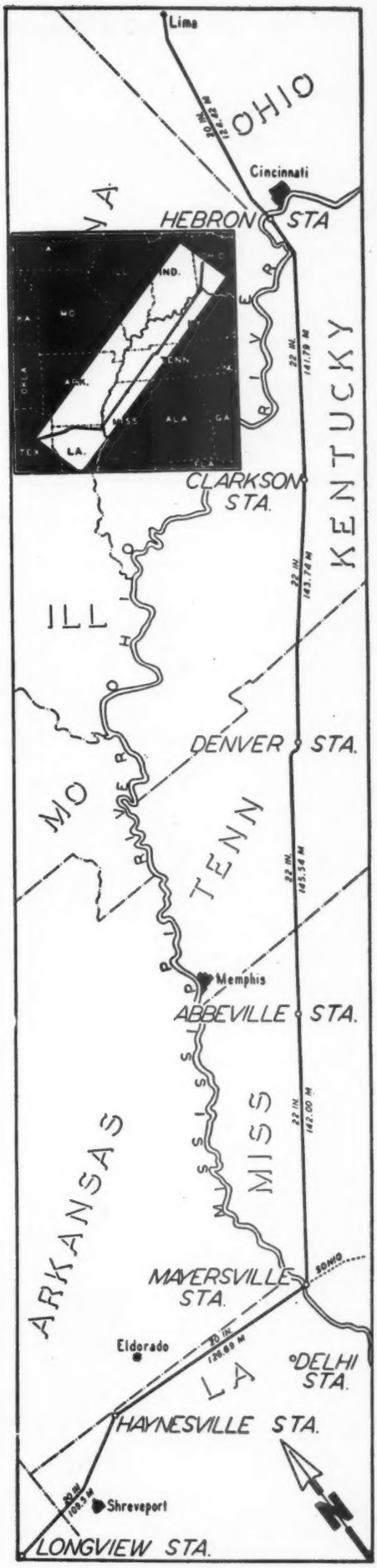
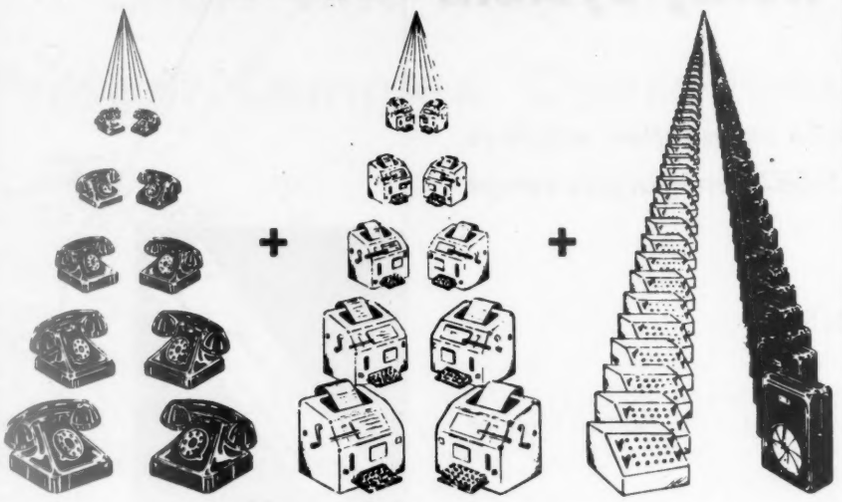


FIG. 1. Map of Mid-Valley route.

*Motorola, Inc.

EXCLUSIVE

FIG. 2. Typical channel utilization.



sive tests show superior performance in fidelity, constant signal levels, and freedom for channelizing when compared to land line or low frequency radio circuits. Voice, telegraph, teletype, and other intelligence can be multiplexed over one microwave relay, as shown by the typical breakdown, Fig. 2.

Microwave relay frequencies provide marked expanded bandwidths for complex signal communications. As the same frequency can be used over and over again in different locations, or in different directions from the same location, there is a practically unlimited supply of communications channels.

Each repeater station incorporates equipment with which the microwave radiation, carrying subcarrier intelligence signals, is demodulated, re-amplified, and transmitted on along the route. Fig. 3 gives a visual description of the make-up of such a system.

The Motorola System

The single antenna for both transmission and demodulation, and the 45-deg flat passive reflectors on the top of the towers of Mid-Valley's microwave communications system were first used by Motorola in practical systems. As shown in Fig. 4, the antenna and all electrical equipment are placed on the ground and easily accessible for servicing.

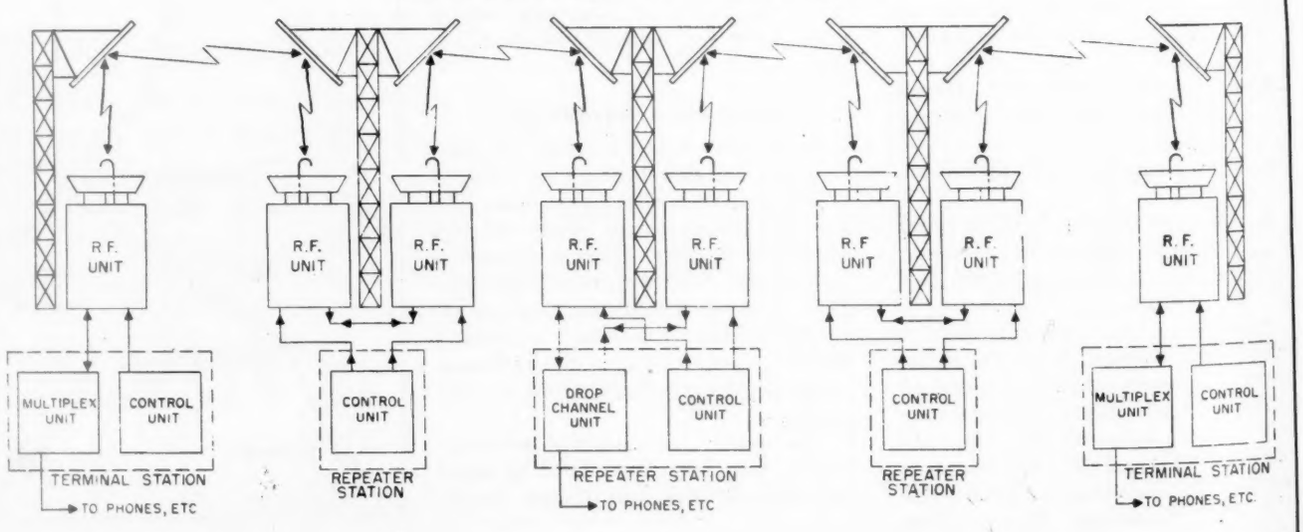
The passive tower-top reflector, a special sheet of reinforced metal perforated to reduce wind resistance, has no cable, waveguide, or other electrical connection to the ground-level installation. The reflector requires no further adjustment after initial tower-top installation and orientation is completed.

On top of each housing is mounted an integrated waveguide-horn and 40-in. paraboloid reflector. At the terminal stations a single parabolic reflector projects the microwave beam, with a 3½-deg angle, to the flat passive reflector to be re-directed horizontally toward the tower of the first relay station, probably 20 miles or so away. The beam striking an intervening reflector is cast downward to a parabolic reflector assembly beneath it. (Refer again to Fig. 3.).

Two outdoor weatherproof aluminum housings containing the "radio frequency" stages are installed, along with other necessary equipment, at each microwave relay point. Fig. 5 shows a typical Mid-Valley repeater station. At some sites the RF cabinets are erected within specially-designed walled-in patios built into the station houses. The beam is amplified, and retransmitted from the antenna of the second RF housing to the reflector above, and then on its way again to the next relay station. This process continues until the beam, and the signals impressed on it, arrive at the terminal point or other desired intermediate station.

A microwave-controlled VHF transmitter and receiver unit for mobile communications is mounted on each relay station tower along the Mid-Valley system. The network is divided into seven sections for mobile communications, any one or more of

FIG. 3. Block diagram of microwave system.



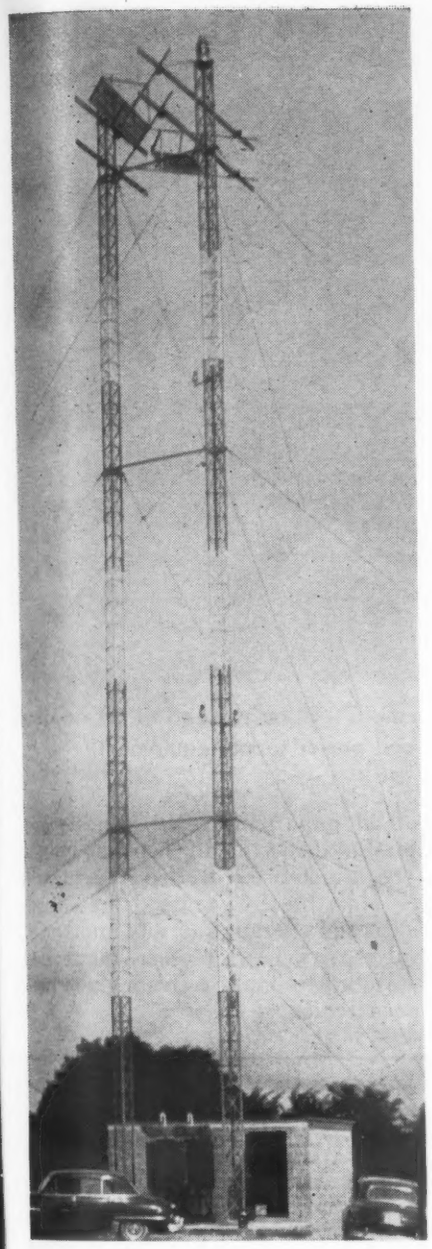


FIG. 4. Microwave tower.

which may be activated at one time. The transmitted signals move over the microwave carrier to all the repeater stations within the desired section where these signals are superimposed on carrier waves of the Mid-Valley mobile FM 2-way radio frequency.

Automatic Standby

Complete automatic switchover standby equipment including separate cabinets and power supplies is incorporated in the microwave relay systems to provide absolute circuit reliability. RF housings are constructed to include two complete transmitter-demodulator units, one for regular operation, one for emergencies. Fig. 6 shows a close-up of the standby portion of one of the RF housings along the Mid-Valley system.

Sensing circuits built into the equipment can recognize a failure of any tube or component and automatically switch over to the standby gear providing maximum continuity of communciations. Fig. 7 shows the standby section of the control and power supply equipment.

Frequency Choice

The frequency range of 6575-6875 mc was chosen by the manufacturer as a result of extensive field tests and lengthy analysis of recent propagation studies, particularly those conducted by the federal agencies.

These facts were taken into consideration in making the selection:

1. The range had to be high enough to use compact, high-gain antennas adaptable to efficient de-icing, and directive enough to be relatively free from mutual interference effects with nearby systems.
2. Radio frequencies in the 6700-megacycle band can be conducted by rigid waveguide, rather than by coaxial cables required by lower VHF frequencies.
3. Waveguides in Motorola equipment have a cut-off frequency of 4300 mc, another major feature because all stray transmissions on lower frequencies are unable to penetrate the demodulator.
4. Choice of the 6000 megacycle band provides opportunity to obtain maximum advantage of the excellent Klystron tube characteristics, particularly with respect to long life and low cost maintenance.

Subcarrier Multiplex

Subcarrier multiplex microwave relay is selected for industrial communications systems for a number of reasons besides its ability to overcome the inherent weaknesses associated with land line communications.

Frequency response characteristics, signal-to-noise ratio, and output levels of subcarrier multiplex microwave transmission are nearly constant, while land line characteristics, for instance, vary greatly from day to day due to line impedance variations, induced voltages, and various types of leakage.

On Mid-Valley's network, with a frequency band 10 megacycles wide, the subcarrier channels are continuously multiplexed so that many messages or control circuits function simultaneously without interference from each other.

Research by Motorola microwave engineers has shown that double-FM subcarrier multiplex is ideal for private systems that require 10 basic communications channels or less. Structure of the subcarrier transmitters and receivers is comparatively simple, party line usage is flexible, channels can be dropped and reinserted with ease, and the cost of the equipment is comparatively low. Fig. 8 is a block diagram of the multiplex unit. Because of the improvement ratio introduced by the Motorola FM Multiplex system, a superior signal-to-noise ratio is achieved.

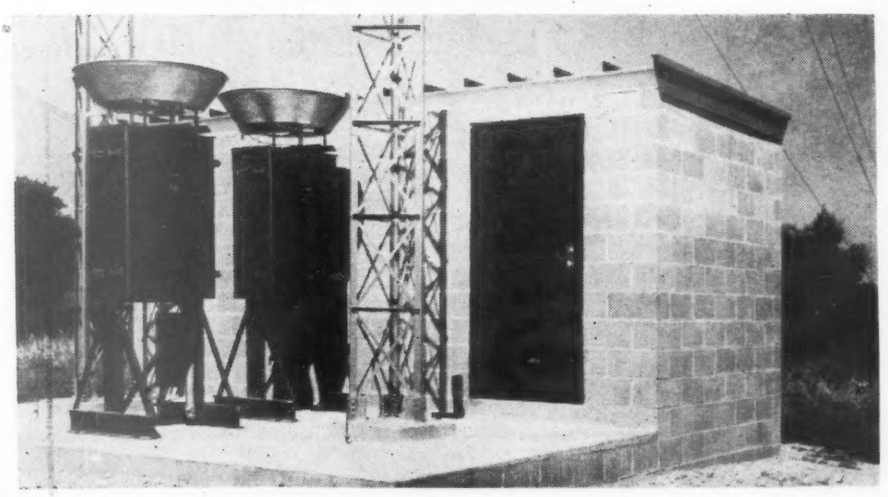
Double Frequency Modulation

Motorola equipment incorporates a double frequency-modulation system in which each input voice channel frequency-modulates an individual subcarrier transmitter on a frequency in the 120-kc to 1-mc range.

Each miniature plug-in subcarrier transmitter employs two double triode tubes, both 6SL7's. One triode is a voice limiter, another is an oscillator, the third is a frequency modulator, and the fourth is a cathode follower.

The output of these subcarrier transmitters is collected into one video cable, which in turn connects to the

FIG. 5. Typical Mid-Valley repeater station.



transmitter klystron to produce the modulated carrier. Wide band deviation of $\pm$ 5 mc for 100 per cent is standard.

At a relay point, the microwave demodulating unit, equipped with a discriminator, recovers the subcarrier frequencies. This video signal then is applied to modulate the transmitter directly in the case of a repeater station, or can be applied to the subcarrier receivers for complete audio detection at the terminal station.

The subcarrier circuits detect the FM signals with conventional limiters and discriminators capable of recovering voice frequencies with unusually excellent quality of reproduction.

System Performance

The Motorola microwave relay system has the inherent ability to concentrate its energy field into a narrow path and direct it with very high power effect to a distant point.

Motorola research and extensive practical experience substantiates the theory that the maximum signal-to-noise ratio is most economically gained with an optimum compromise between beam width, RF power, and demodulator sensitivity. In building high-gain antennas it is vital to select a beam angle wide enough to avoid excessively rigid tower stability requirements, and still directive enough to attain adequate signal-to-noise ratios with full consideration of the practical economics of RF system design.

The system is designed to allow easy and economic future addition of telemetering and supervisory control circuits. With the incorporation of these circuits the positions of all switches, signals, and valves, and the readings of all important meters can be displayed at any or all dispatch points. The remotely controlled system will be able, then, to provide for adjustment and operation of any number of valves, switches, or other unattended devices by simply activating the proper circuits. * * *

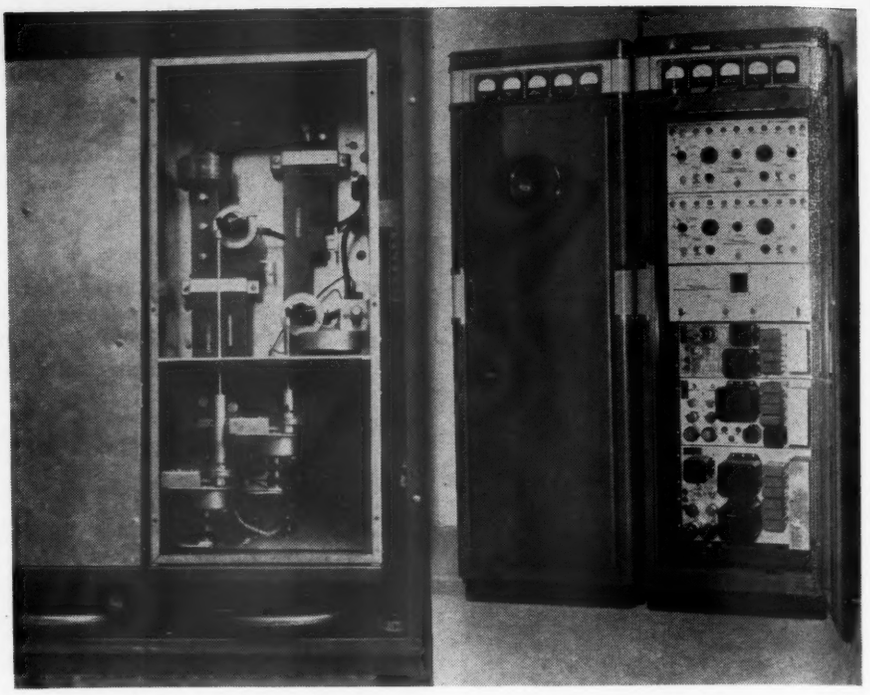
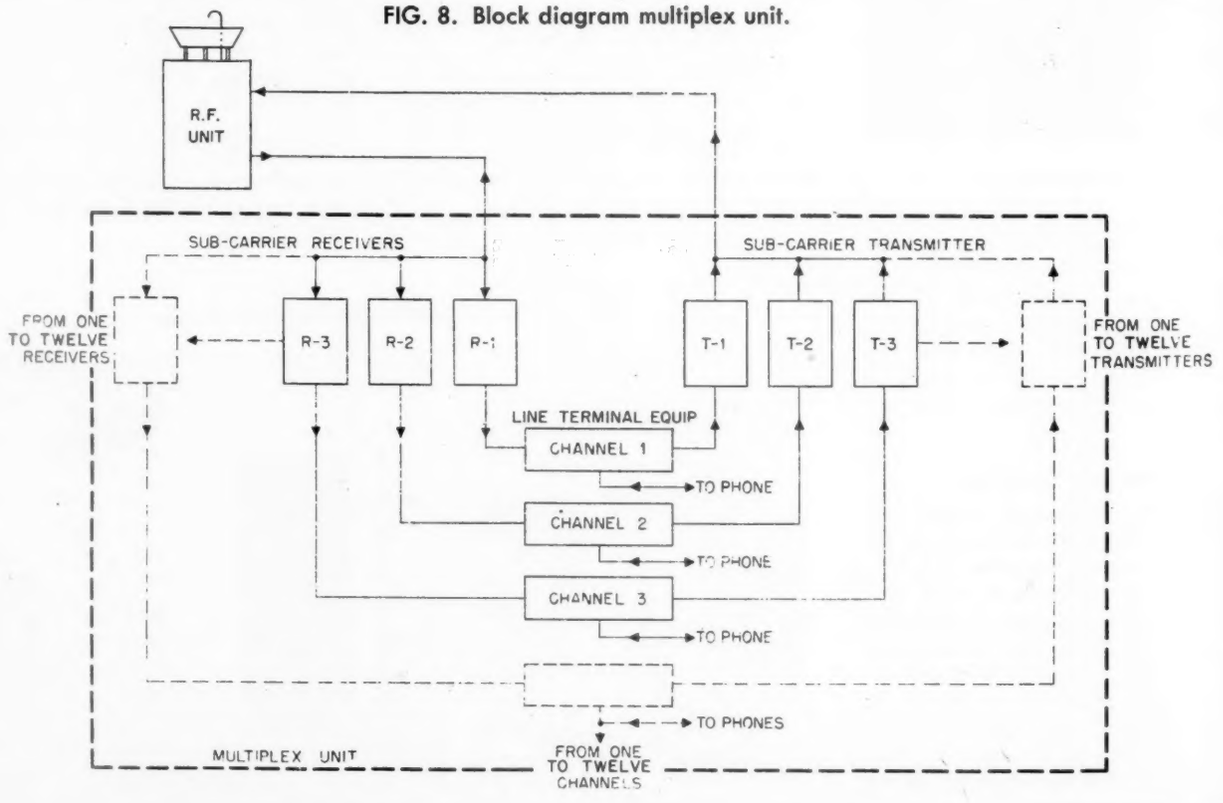


FIG. 6. Standby portion of RF housing along system.

FIG. 7. Standby section of control and power supply equipment.

FIG. 8. Block diagram multiplex unit.



Leaders in Pipe Protection for a Quarter Century

HILL, HUBBELL *Announces*

A New Pipe Protection Plant in the Chicago Area

Hill, Hubbell's new steel pipe coating and wrapping plant, located in Hammond, Indiana, will begin operation June 15, 1951.

This central location is in the heart of the vast mid-western steel pipe producing area which includes East Chicago, Gary, Indiana Harbor, Milwaukee and South Chicago.

Customers in the west and southwest can now take advantage of the Hill, Hubbell process with faster deliveries.

Our new facilities will include "stop-over privileges" for pipe to be coated and wrapped in transit on minimum freight rates.

The new plant has ample space for storage of pipe to be coated and wrapped as you need it.

If you'd like to know more about this new plant, and the advantages of factory coated pipe, please write —

Hill, Hubbell and *Company*

Division of GENERAL PAINT CORPORATION

Headquarters: 3091 Mayfield Road, Cleveland 18, Ohio

USE OF PERMANENT PIPE REPAIR CLAMPS

THE maintenance of pipe lines, both gathering and transmission lines, has always been important. The action of erosion and corrosion upon exposed pipe lines is too well known to require more than a mention. Injury to pipe lines is fairly frequent as well. Whatever the cause a leaking pipe line is unsatisfactory. All companies know this and have expert crews for the purpose of keeping up a high standard of efficiency.

Under present conditions, however, a new factor enters the situation. The scarcity of pipe fittings and couplings, the extraordinarily high price when they can be procured, and the delays in getting them all present a real maintenance problem. Following the same line of reasoning, the use of well designed permanent pipe repair clamps becomes even more of an economy than it has been in the past.

There probably isn't a maintenance man in the country who has not used an emergency pipe clamp*. Made of malleable iron with heavy cadmium plated bolts and pressure distributing gaskets, it is used to seal pits and rust holes. Of the same design, but approximately twice the length, for splits in pipe, is the pipe line clamp. For the same use, but where long range permanence is secondary and an even greater economy is desirable, the pressed steel economy clamp has achieved a very wide usage. An accompanying illustration shows the true forming, the handy lugs that facilitate the free swing to the wrench in applying, and the electroplated bolts. In ordinary use cone plug gaskets are provided for the narrow style and strip gaskets for the wide pattern.

One other leak common to pipe lines deserves attention. That is the leak in the thread of couplings or collars. The collar leak clamp takes care of this condition. The ample size of the gaskets, the design of the gasket container rings (to prevent extrusion), and the simple application of compression bolts, which are adequate in size and plated to resist rust, all are features of this equipment.

* * *

*"Skinner-Seal" product by M. B. Skinner Company.

FIG. 1

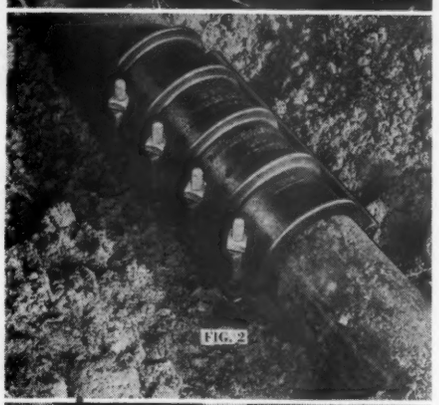


FIG. 2

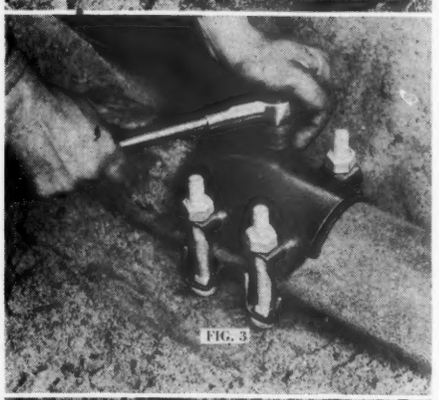


FIG. 3

FIG. 4

FIG. 5

FIG. 1. Emergency pipe clamp; FIG. 2. Pipe line clamp: FIGS. 3 and 4. Pressed steel economy clamp, wide and narrow, respectively; FIG. 5. Collar leak clamp.

West Coast Line Will Transport Viscous Crude

General Petroleum Corporation, Los Angeles, California, has awarded a construction contract in excess of $2,000,000 to the Bechtel Corporation for the salvage of its 38-year old Mojave pipe line and for the line's reinstallation at San Ardo in northern California.

George Supple, General Petroleum's vice president and director of pipe line, in announcing the contract, explained that the new San Ardo line will for the first time provide an economical means of transporting the heavy and highly viscous crude oil found in the field, which has been largely shut in since its discovery in 1947.

"The current high military requirements in the West provided a stimulus for General Petroleum to build this new line which incorporates some unique engineering features," Supple said. The sticky San Ardo crude oil, heretofore impossible to move by ordinary pipe lines, will be made to flow by the use of two devices. First, it will be blended with a light petroleum product brought to the field for the purpose, and, second, it will be heated to over 170 F.

Under the new contract, Bechtel will take up 43 miles of 8-in. pipe, originally laid in 1913 to connect General Petroleum's Lebec refinery high in the Tehachapi Mountains with the Mojave refueling station of the Santa Fe Railway.

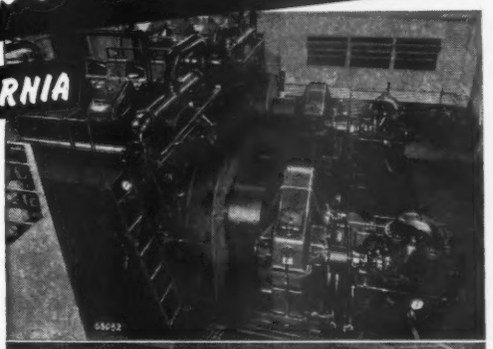
The pipe will be cleaned and prepared for welding at a plant in San Miguel, California. It will be re-laid in a 40-mile direct line between the San Ardo field and the sea and will be in operation about June 1.

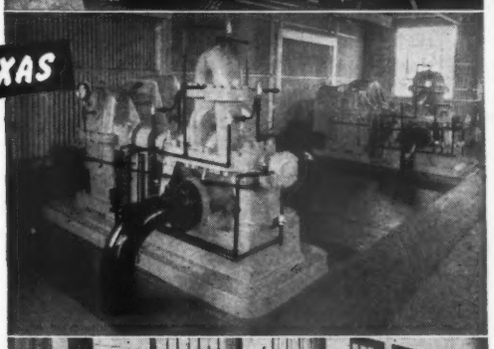
The shift of Santa Fe's engines from steam to diesel had made the Mojave line unnecessary, Supple explained. The new diesel engines can carry enough fuel from Los Angeles to cross the eastern California deserts without re-fueling.

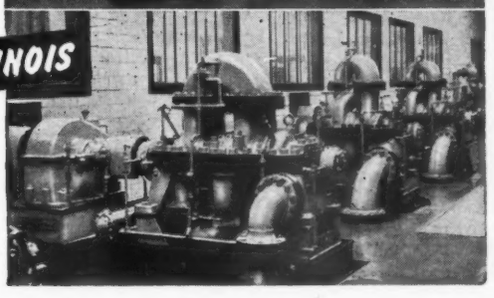
Paralleling the 8-in. line at San Ardo will be a smaller line, which will carry the light petroleum product to be blended with the San Ardo crude oil. When the "flow-ability" of the San Ardo crude oil has been improved enough by blending and heating, it will be pumped to a marine loading plant at Estero Bay to be taken away by tankers.

Three steam-powered and one electric pumping stations will be erected along the 40-mile pipe line route. The steam pumps have also been salvaged from the old Mojave line. Each station will have facilities for re-heating the oil as it passes through.

Many pipelines depend on I-R pumps like these







Moving liquids through the world's vast network of pipelines requires the service of *thoroughly reliable and efficient pumps* ... proven pumps that will perform their task continuously, 24 hours a day.

That's why Ingersoll-Rand "RT" pumps are used so extensively for pipeline service. These are heavy-duty units having the stamina to stay on the job with a minimum of attention. Carefully designed impellers and large, smooth liquid passages assure high sustained hydraulic efficiency and low power costs.

As an added feature, "RT" pumps can be equipped with the Cameron Shaft-Seal which replaces conventional stuffing-box packing and practically eliminates stuffing-box maintenance.

An Ingersoll-Rand engineer will be glad to help you with your pumping problems. Be sure and ask him for a copy of Catalog 7148 describing "RT" pumps.

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Since 1860 . . . Pioneering in the development of better pumps.

Highlights of AGA Spring Meeting in Dallas

The tremendous growth of the natural gas industry and its dynamic rise in importance in residential, industrial, and commercial fields is stimulating an ever-increasing interest in this popular fuel. A reflection of this growing importance is seen in the record attendance of more than 1000 delegates at the Spring meeting of the Natural Gas Department of the American Gas Association being held at the Hotel Baker, Dallas, Texas, May 7 and 8.

The advent of natural gas in new territories served by manufactured and mixed gas has created new concepts and problems. Regulations, materials, research, public relations, storage, and communications are a few of the phases of natural gas operations that are strong in the minds of gas utility executives today. The program committee for the spring conference, under the guidance of Elmer F. Schmidt, vice president, Lone Star Gas Company, Dallas, Texas, and chairman of the conference program committee, has enrolled a cast of speakers and discussion leaders well qualified to ably present these and other pertinent subjects to the delegates in an illuminating and profitable manner.

C. E. Bennett, vice president of AGA, and president of the Manufacturers Light and Heat Company, Pittsburgh, is chairman of the AGA Natural Gas Department and will preside at the general sessions at the conference. Bennett will give the opening remarks at the general session on Monday morning and will be followed by the Mayor of Dallas, who will welcome delegates to the city. D. A. Hulcy, president of AGA, and president of the Lone Star Gas Company, will speak on "The Association and the Industry." Steel plays an important role in the spread of the natural gas industry across the continent and in its daily operations. John E. Goble, president, National Tube Company, Pittsburgh, one of the nation's largest fabricators of steel pipe, will inform delegates on the steel situation.

Frank H. Lerch, Jr., president, Consolidated Natural Gas Company, is well known in gas industry and financial circles. From his key position in the direction of natural gas systems, he is splendidly qualified to talk on "Regulation and Legislation from the Management's Viewpoint."

Research is playing a leading part in the development of the natural gas industry, and Elmer F. Schmidt, chairman of the technical and research committee of AGA, has helped direct the projects under the gas industry's accelerated research program that are devoted specifically to natural gas problems. He will outline these projects at the general session on Monday.

D. A. Hulcy
President, American Gas Association
President, Lone Star Gas Company

The Railroad Commission of Texas has been an active ally of the gas industry in promoting conservation of natural gas and in endeavoring to obtain equitable treatment for the industry in regulation and supervision. Olin Culberson, chairman of the Texas Commission, will have some interesting viewpoints to offer at the Tuesday general session. Profiting by past experience, the natural gas industry demanded and obtained early representation in Washington. An industry committee has an important voice in the defense picture. Bruce K. Brown, Deputy Administrator, Petroleum Administration for Defense, Washington, will talk on "Economy of Natural Gas in Defense Mobiliziation."

Another aspect of natural gas in relation to national defense will be presented at the Tuesday morning session by Paul Kayser, president, El Paso Natural Gas Company, Houston.

The postwar era has brought a tremendous growth in residential and industrial customers to the West Coast utilities, necessitating the construction of great new natural gas transmission lines. One of these, a 500-mile line from the Arizona-California border to San Francisco Bay, is 34-in. in diameter, truly the "Biggest Inch." James S. Moulton, vice president, Pacific Gas and Electric Company, San Francisco, will introduce a color motion picture film featuring the construction of this part of "The Biggest Inch" pipe line.

Open meetings will be held both afternoons under sponsorship of the transmission committee of the Natural Gas Department. M. V. Burlingame, Natural Gas Pipeline Company of America, Chicago, is chairman of this committee, and his program will

present subjects of interest to almost every segment of the natural gas industry.

J. S. Quill, General Electric Company, Schenectady, New York, and J. H. Eichelmann, El Paso Natural Gas Company, El Paso, Texas, will present the manufacturers' and the operators' views on gas turbines for compressor stations. J. S. Bailey, Continental Oil Company, Ponca City, Oklahoma, will discuss results from using pulsation dampeners in meter stations, and The Fluor Corporation has prepared a paper on the use of such dampeners in compressor station operation.

Pipe line right-of-way maintenance is an important subject to be handled by Arthur W. Emerson, soil conservation specialist with the U. S. Department of Agriculture. H. A. Rhodes, Transcontinental Gas Pipe Line Corporation, will describe "Modern Communications, the Nerve Center of Pipe Line Systems," and A. A. Cullman, chairman, AGA Accounting Section, and assistant treasurer of Columbia Engineering Corporation, New York, will talk on some of the operating aspects of gas storage accounting.

To Apply Somastic to 137 Miles Gas Line

The H. C. Price Company of Bartlesville, Oklahoma, is making final preparations to apply Somastic coating to 137 miles of large diameter pipe, which will be used in connection with the major expansion program recently announced by United Gas Pipe Line Company, Shreveport, Louisiana.

This coating operation represents one of the largest ever undertaken by Price's Somastic Division. It is estimated that more than 35,000,000 lb of material will be required.

The Price company will set up a new Somastic plant east of Morgan City, Louisiana, to facilitate the United Gas undertaking. It will be under the supervision of R. P. White, Gulf Coast division manager, and Nelson VerSoy, plant superintendent.

The 137 miles of pipe to be coated comprise a vital portion of the $112,000,000 expansion program that the Federal Power Commission recently approved for United Gas. The 137 miles will be laid through swampy regions in south central Louisiana where the corrosion problem is particularly acute.

The United Gas contract covers the application of a 9/16-in. Somastic coating to 12.3 miles of 14-in. and 13.4 miles of 16-in.; a ⅝-in. coating to 21.1 miles of 20-in., 15.5 miles of 20½-in., 24.6 miles of 24-in., 23.8 miles of 26-in., and 26.3 miles of 30-in.

Sinclair Installs Long Carrier Telephone System

One of the longer industrial carrier telephone systems to be installed in the United States was completed recently by the Sinclair Pipe Line Company in Independence, Kansas. It extends from the company's main office in Independence to a Sinclair division office in Fort Worth, Texas, a distance of approximately 450 miles.

The equipment — a 9-B-1 three-channel long-haul carrier telephone system, consisting of two 3-channel terminals and two repeaters — was manufactured for the Sinclair Pipe Line Company by Federal Telephone and Radio Corporation, Clifton, New Jersey, manufacturing associate of the International Telephone and Telegraph Corporation.

The Federal carrier equipment, which was placed on an existing pair of wires between Independence and Fort Worth, provides the Sinclair Pipe Line Company with three additional high-quality telephone channels.

The Independence-Fort Worth installation is part of an integrated communication system operated and maintained by Sinclair in the middle and southwestern United States.

NATASCO SERVICE GIVES YOU 3-WAY SAVINGS

SAVES TANKS - SAVES STEEL

Having new tanks treated by NATASCO is the sure way of getting the ultimate in use from them over a long period of years. Old tanks will also give many years additional service by receiving the proper NATASCO treatment. NATASCO protects the steel surface from all corrosion. Due to the increasing shortage of steel, and its rising cost, NATASCO service provides substantial savings.

SAVES OIL

Evaporation of volatile fractions and loss through leakage has accounted for smaller profits in many oil firms. In most cases *this loss could have been prevented if the tanks had been serviced by NATASCO.*

SAVES DOLLARS

If you have added additional years of service life to your tanks and have eliminated loss by evaporation and leakage, *you have added profits to your business.*

Every NATASCO job is Guaranteed

Wire, Write or Telephone for complete information on how NATASCO can solve your corrosion problems.

PROTECTS TANKS AGAINST CORROSION

THE Natasco COMPANY

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C-R-C Cleaning & Priming Machines

Only one run over bad pipe is necessary to thoroughly clean it with the Model "C" Cleaning and Priming Machine.

This time-saving feature is possible because *two* transmissions are used. This gives the operator complete control of the ratio of forward speed of the machine and the r.p.m of the cleaning head.

CHECK THESE OTHER FEATURES

- **Perfect balance and lower center of gravity**
- **For pipe from 3" to the largest made**
- **Four-wheel drive with individual speed reducers**
- **Exposed driving mechanism covered by guards**
- **All moving parts and friction points flame hardened**
- **Can be mounted on stationary base allowing handling of pipe one size larger and several sizes smaller than rated line travel capacity**

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Pipe Line Equipment and Supplies

HOUSTON, TEXAS — TULSA, OKLAHOMA

• ***There's no Match for C-R-C Equipment PLUS C-R-C Service and Experience***

API Division of Transportation to Hold Products Pipe Line Meet

The American Petroleum Institute, Division of Transportation, is holding a products pipe line technology conference in Atlanta, Georgia, May 21 to 23.

The conference will begin Monday morning with a symposium at 9 a.m. with J. W. De Groot, president, Tuscarora Oil Company, Ltd., presiding. Symposium topics will be:

Monday

Fire Protection Facilities for Products Pipe Lines.

(a) Experience in Terminal and Pipe Line Protection by J. P. West, Sohio Pipe Line Company, St. Louis, Missouri.

(b) Description of Fog Foam Installation, H. C. Van Nouhuys, Southeastern Pipe Line Company, Atlanta, Georgia.

Resume of Filtering Practices, by M. J. Dabney, Plantation Pipe Line Company, Atlanta, Georgia.

The Pipe Line Transportation and Storage of LP Gas, by David A. Roach, Phillips Petroleum Company, Bartlesville, Oklahoma.

The afternoon session at 2 p.m. in the same place will have the following topics and speakers:

Conservation Characteristics of Various Types of Petroleum Products Storage Tanks, by S. S. Smith, Shell Oil Company, New York.

Products Pipe Line Scraping Operations, by W. S. Schmidt and Allen Baxter, Keystone Pipe Line Company. Philadelphia, Pennsylvania.

Conversion of Crude Pipe Lines to Products Service, by Earl W. Unruh, Sinclair Refining Company, New York.

Tuesday

A field trip is scheduled for Tuesday when members will leave the Biltmore Hotel at 8 a.m. and return at 5 p.m.

There will be bus transportation for those making the trip with scheduled stops at Plantation Pipe Line Company and Southeastern Pipe Line Company stations at Chattahoochie, Bremen, and Doraville. The Southeastern Pipe Line Company has arranged to put on a fog foam demonstration at its Chattahoochie station.

A nominal fee to defray transportation and luncheon expense will be assessed each conferee making the field trip, at time of registration.

Wednesday

L. F. Scherer, assistant manager, construction and engineering, Texas Pipe Line Company, Houston, Texas, will be moderator for the Wednesday morning meeting, beginning at 9 a.m. in the same room. Panel members for a round table discussion include:

J. G. Norton, Magnolia Pipe Line Company; W. S. Schmidt, Keystone Pipe Line Company; M. L. Barrett, Shell Oil Company; L. R. Williams, The Pure Oil Company; H. R. Hoyt, Great Lakes Pipe Line Company; F. Armstrong, Plantation Pipe Line Company; J. S. Hendrickson, Sinclair Pipe Line Company, and J. W. Boyd, Phillips Petroleum Company.

At the 2 o'clock afternoon session round table discussions will be held with members of the panel group on problems pertaining to products pipe line technology. There will also be an inspection trip through the Georgia Tech Hydraulics Laboratory and a review of cost accounting practices in the Plantation Pipe Line Company's cost accounting office.

THERE IS NO SECRET TO PIPELINING: *IT TAKES*

- ***Good Equipment***
- ***Experienced Personnel***
- ***Expert Supervision***

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NEWS

Texas Eastern Plans Microwave System

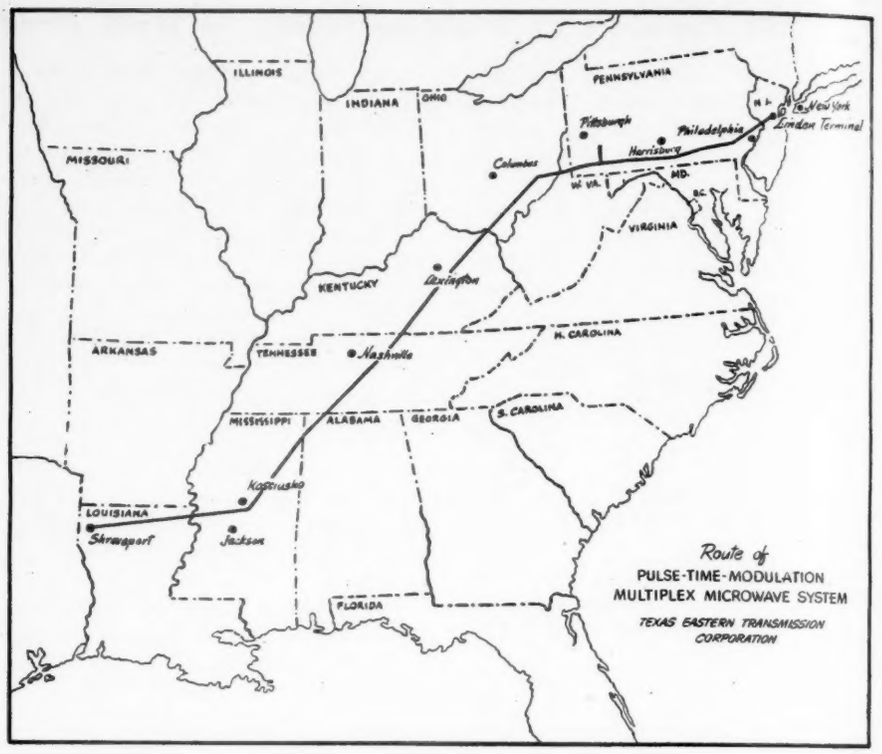
Plans for one of the most extensive and modern microwave systems in the United States have been announced by Texas Eastern Transmission Corporation, Shreveport, Louisiana. Designed to expedite the flow of natural gas from Louisiana and Texas fields to the highly industrial East, the system will employ pulse time modulation multiplex equipment developed and manufactured by Federal Telephone and Telegraph Corporation, Clifton, New Jersey, associate of International Telephone and Telegraph Corporation. The installation of the equipment will also be handled by Federal.

The route of the system will be from the company headquarters at Shreveport, to Kosciusko, Mississippi, then along the route of the 30 in. pipe line now under construction to Connellsville, Pennsylvania, and from there to the eastern terminal of the company's lines at Linden, New Jersey—a distance of approximately 1400 miles. This system will provide various communication facilities between Shreveport, the pipe line compressor stations, and divisional offices along this route.

Initially, it will be equipped for operation on eight voice channels, with provision for VHF mobile radio connection, dispatching, administrative, telemetering, and supervisory services. Should additional facilities be necessary, the system may be readily expanded to provide 23 channels.

At 2000 megacycles de-icing heaters are not necessary for vertical paraboloids and rigidity requirements for towers are lessened. Other features include simple, common channeling units; independently operated repeater sections and simplified repeater drop and insert equipment.

A survey of the 1400 mile route is now being undertaken to determine the best location for the microwave repeater stations. Upon the completion of the survey, construction of microwave towers and equipment housing will proceed immediately.



South Central Corrosion Engineers to Meet

The annual meeting of South Central Region, National Association of Corrosion Engineers, will be held October 18, 19, and 20 at Corpus Christi, Texas. George A. Mills of Central Power and Light Company, Corpus Christi, is general chairman of the meeting. Attendance of about 250 is indicated.

T. S. Johnston New President Interprovincial

T. S. Johnston, Toronto, Ontario, Canada, formerly vice president of Interprovincial Pipe Line Company, was elected president at a meeting of directors recently. He succeeds Dr. O. B. Hopkins, who did not stand for re-election as president because of duties he has assumed as director of the Petroleum Division of the Department of Defense Production.

Loren F. Kahle, Edmonton, was re-elected executive vice president and F. G. Hall, president.

At the annual general meeting of the shareholders, which preceded the directors' meeting, Dr. Hopkins said Alberta crude oil has been steadily moving through the company's line and into its 1,800,000 barrel tankage at Superior. Loading of the first tanker is expected to take place there about April 21, he said.

Directors elected at the annual meeting were: C. E. Carson, T. F. Moore, D. R. A. Walker, J. R. White, W. J. Wilkins, Dr. O. B. Hopkins, F. G. Hall, T. S. Johnston and Loren F. Kahle.

In taking over his new duties as president, Mr. Johnston brings to the job many years of experience in the oil industry. After graduation from college he began work with the Standard Shipping Company in 1928 and has been employed in oil transport operations ever since.

In January, 1941, he became assistant manager of the marine department of the Lago Oil and Transport Company at Aruba in the Netherlands West Indies. He later saw service in Colombia, Ecuador and Peru in South America.

Early in 1945 he returned to Canada as assistant manager of Imperial Oil's marine department, becoming manager in December, 1945. In 1947 he was appointed assistant to Imperial's vice president in charge of transportation and supply and held that post until the end of 1949 when he became vice president of Interprovincial.

Promotions

▸ **Elmer Draper,** division dispatcher at Freeman, Missouri, for Service Pipe Line Company, has been promoted to chief division dispatcher. His headquarters will remain at Freeman and his new duties will make him responsible for dispatching of oil in the Missouri and Illinois divisions under the guidance of chief oil dispatcher **Ray Harvey** at Tulsa, Oklahoma.

▸ **Roy E. Burgess** has been made administrative assistant in the Pipe Line Division of H. C. Price Company, Bartlesville, Oklahoma. He has been office manager for Spread 2 the last six years.

▸ **Otto Fillingame,** for 23 years a compressor station man in the New Orleans district, has been transferred to the Shreveport district as chief engineer at Rodessa station, by United Gas Pipe Line Company.

New Contracting Firm Organized

Great interest has been evidenced in the petroleum and natural gas pipe line construction industry over the recent formal announcement of the organization of a new firm of major proportions. This firm, under the name of Western Pipe Line Constructors, Inc., is in effect a merger of the talents and certain key personnel of two widely known concerns in the pipe line industry, Morrison Construction Company and H. C. Price Company.

Western Pipe Line Constructors is headed up by James P. Neill, president, Charles S. LeNoir, vice president, and E. G. Morrison, secretary. The latter formerly was president of Morrison Construction Company of Austin, Texas, and Neill and LeNoir were, until recently, vice president and general superintendent of the Price Company. The firm has already purchased well over $2,000,000 worth of heavy construction equipment and has booked construction contracts in excess of $7,000,000. Two big-inch pipe line spreads are now in operation and the third spread is in the formulative stages and expected to be in operation within 30 days. The two spreads are now beginning work on a major pipe line project for Tennessee Gas Transmission Company of Houston, Texas. This project calls for the construction of approximately 120 miles of 30-inch natural gas pipe line in Kentucky and Tennessee, and also includes three major river crossings, namely the Duck River, the Buffalo River, and the Tennessee River.

Headquarters for the company have been established in the Lockhart Building at Austin, Texas. Spread superintendents now employed by the firm are W. B. Williams, R. L. McMillon, and Jack Hodges. These superintendents are also widely known throughout the industry and have a considerable background of successful pipe line construction experience. George Marsh, formerly a partner of the accounting firm of Wade, Barton and Marsh, has resigned from this partnership and been appointed vice president and treasurer of the new firm. John W. Foster, of Austin, has been engaged as general office manager.

Western has become an active member of the Pipe Line Contractors Association and E. G. Morrison, a director of the association, will retain his present two-year directorship. J. P. Neill, having been active in the formation of this association, will continue to serve as chairman of the program committee.

In keeping with the trend towards better stabilization of employee-employer relationship in the industry, plans have been made to institute a liberal employees profit sharing and pension plan together with group life and health and accident insurance. Application for approval of the pension plan has been filed with the United States Treasury Department and is now awaiting approval.

James P. Neill | E. C. Morrison | Charles S. LeNoir

El Paso Natural is Installing Microwave

Featuring some of the longest links between terminals ever used in a microwave relay system, a 500-mile Philco communications system is being installed for the El Paso Natural Gas Company.

The new relay, which will run between Fruitland, New Mexico, and a point in Arizona near the California border, is using microwave links that average 50 miles between mountain top sites. In microwave systems previously installed, distances between relay stations have averaged 20-40 miles, but in this installation several convenient mountain tops will be utilized to make possible longer links between repeaters or relay "booster" stations.

Microwave equipment for this installation was developed in the Philco laboratories and can handle 24 simultaneous telephone conversations or several hundred teletype or telemeter channels.

Route survey and systems engineering for the San Juan microwave installation in New Mexico and Arizona was carried out by L. Duthie, communications engineer for the El Paso Natural Gas Company under the general supervision of Lon G. Wainman, superintendent of communications.

Philco, pioneer in microwave relays since 1931, is providing equipment for nearly 10,000 miles of microwave relay systems to industrial customers, including railroads, pipe lines, telephone, telegraph and television common carriers, utilities; and to several government departments.

United Gas Awards $25,000,000 Contract

United Gas Pipe Line Company has awarded a $25,000,000 contract to Gulf Southern Contractors of Fort Worth, Texas, for construction work on approximately 1000 miles of natural gas pipe lines.

The construction work will be within the states of Texas, Louisiana, and Mississippi, according to M. A. Abernathy, United Gas vice president.

Gulf Southern is a contracting group composed of Texas-Louisiana Contractors of Fort Worth; Oklahoma Contracting Company, Dallas; J. Ray McDermott and Company, Inc., New Orleans; and Morrison-Knudson Company, Inc., of Boise, Idaho. Robert Thomas of Fort Worth heads up the contracting group.

Pipe is now being shipped to yards for storage and coating.

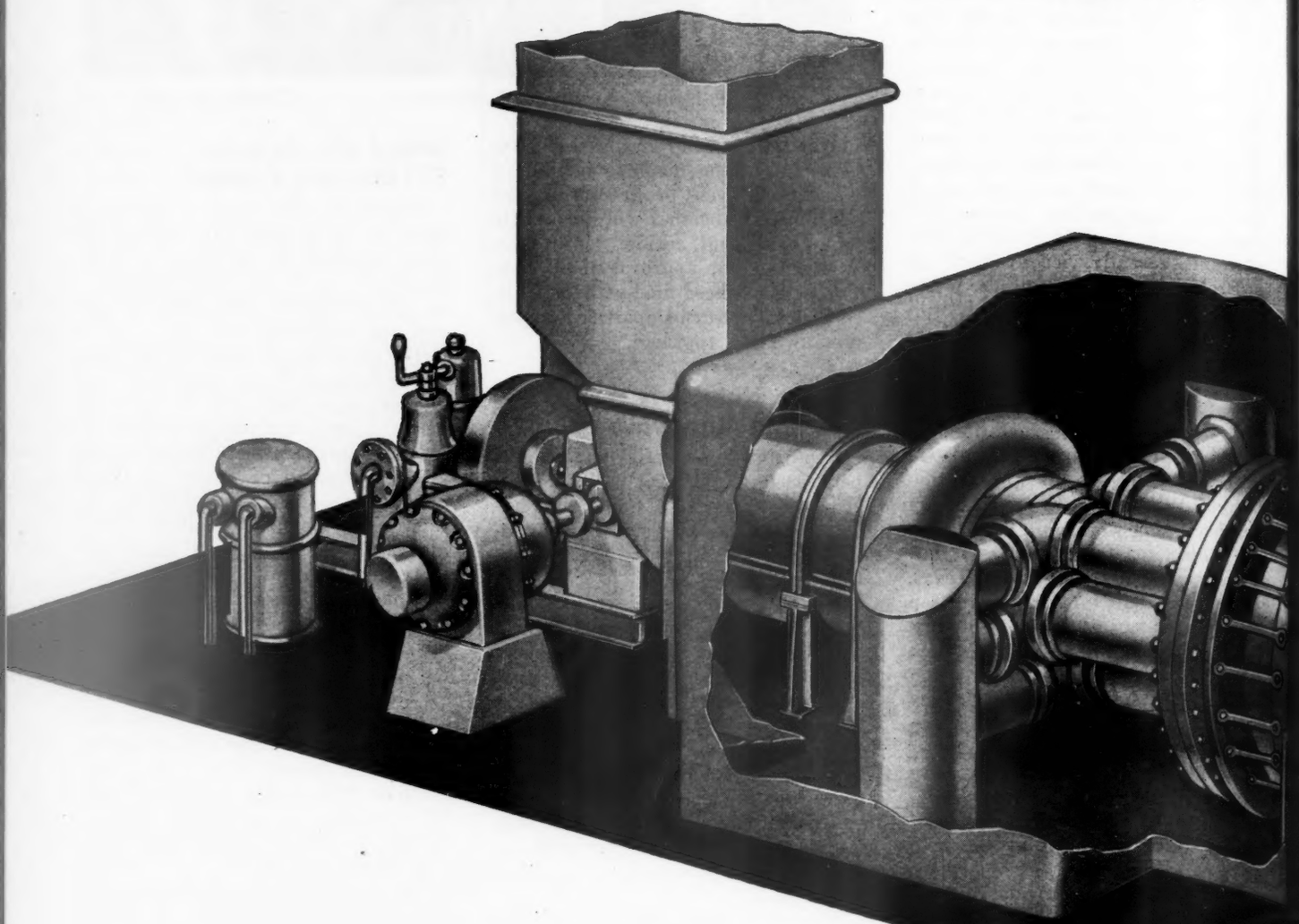
Award of pipe line construction work to Gulf Southern Contractors follows the letting of a contract recently to Brown & Root, Inc., of Houston, covering various phases of engineering, construction, and other services on the project.

The construction project was authorized under a certificate of public convenience and necessity issued by the Federal Power Commission to United Gas late in February. When completed the new facilities will provide an initial increase in the capacity of the pipe line system of approximately 920,000,000 cu ft of natural gas a day. Cost of the entire project is estimated to be $111,000,000.

In addition to the new lines in Louisiana, Texas, and Mississippi, the construction program also provides for a 20-in. line extending approximately 15 miles into the Gulf of Mexico from the Louisiana coast. This line will tie in new reserves to United's system from the Eugene Island area. Construction at an early date of additional lines to connect with other wells in the Gulf in the same general area is also contemplated.

ANNOUNCING the G-E

specially designed



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combustion GAS TURBINE
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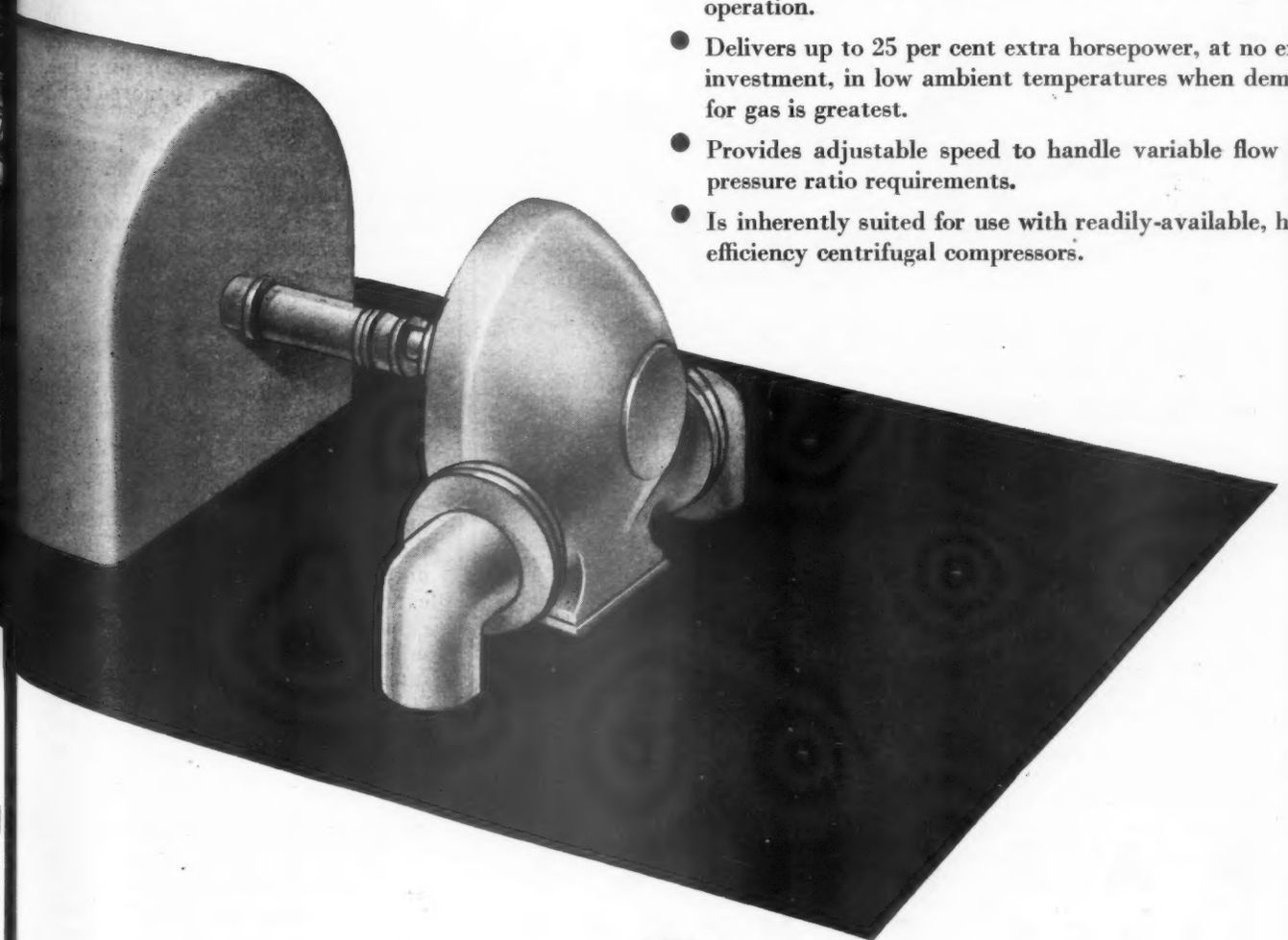
Now—a complete, practical and reliable G-E prime mover for direct connection to high-efficiency centrifugal compressors—to help you cut gas pipeline pumping costs!

Behind the development of this gas turbine is the engineering, the experience, and the resources of General Electric—your assurance of reliability in operation. Ask your G-E representative to discuss the application of the G-E gas-pipeline gas turbine to *your* operation. *General Electric Company, Schenectady 5, N. Y.*

Here's the story in brief!

- Rated 5000 hp, 5000 rpm, at 1000-foot altitude and 80 F ambient temperature.
- Permits simplified station layout and relatively small buildings to cut construction costs.
- Requires little or no make-up water, an important factor especially in desert country.
- Is entirely self-sustaining, using gas from the line as fuel.
- Readily lends itself to remote supervisory control, because it is self-protecting and completely automatic in operation.
- Delivers up to 25 per cent extra horsepower, at no extra investment, in low ambient temperatures when demand for gas is greatest.
- Provides adjustable speed to handle variable flow and pressure ratio requirements.
- Is inherently suited for use with readily-available, high-efficiency centrifugal compressors.



GENERAL ELECTRIC

661-28

Heavy Coatings for Transco Extensions

Two important extensions of the Transcontinental Gas Pipe Line Corporation system will receive Somastic and Hevicote applications, according to an announcement by H. C. Price Company of Bartlesville, Oklahoma.

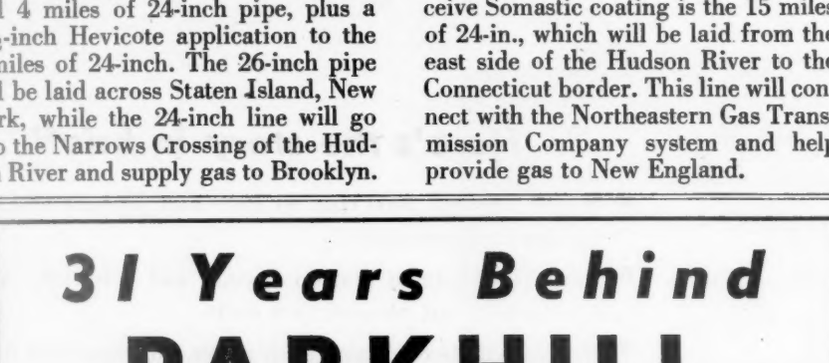
The first of these extensions will require the application of a 5/8-in. Somastic coating to 10 miles of 26-inch and 4 miles of 24-inch pipe, plus a 2½-inch Hevicote application to the 4 miles of 24-inch. The 26-inch pipe will be laid across Staten Island, New York, while the 24-inch line will go into the Narrows Crossing of the Hudson River and supply gas to Brooklyn.

It is estimated that more than 40 carloads of material will be required for the Hevicote application alone. This coating will be reinforced with one wrap of 2-in. by 2-in. 14-gage and one wrap of 1-in. by 18- in. gage galvanized wire and will weigh approximately 200 lb per lineal ft.

A second Transco extension to receive Somastic coating is the 15 miles of 24-in., which will be laid from the east side of the Hudson River to the Connecticut border. This line will connect with the Northeastern Gas Transmission Company system and help provide gas to New England.

31 Years Behind

PARKHILL



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- "KNOW HOW" . . . gained through 31 years of broad experience under all seasonal, climatic and topographical conditions.
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Construction Begins On Phillips' West Texas Line

Actual construction of a new crude oil trunk line and gathering system is underway in the prolific Spraberry trend in West Texas, according to an announcement by K. S. Adams, president of Phillips Petroleum Company.

These lines, to extend throughout the prospective producing territory of Midland, Glasscock, Reagan, and Upton counties, will be in a position to serve all production from this area. Although details of exact ownership have not been determined, it is contemplated that the pipe line will be a joint venture with Phillips the operator. Cities Service Oil Company is expected to have a substantial interest.

The gathering system will tie in at Goldsmith, Texas, with Phillips present 12-in. main crude oil line to Borger, Texas. This will enable the movement of additional oil to the company's refinery at Borger or to its refineries at Okmulgee, Oklahoma, and Kansas City, Kansas. At Midland, Texas, the system will tie into facilities in which Cities Service Oil Company is part owner, namely the Basin Pipe Line, through which oil can be transported to Oklahoma, and the proposed West Texas-Gulf pipe line, through which oil can be moved to the Gulf Coast.

Recent drilling indicates large reserves throughout the trend in which Phillips has 18,280 acres of leases. Phillips also holds commitments from a number of large leaseholders to run their crude production.

Texas Gas Reserves Good for 25 Years

The Texas Railroad Commission has reported that Texas' proved recoverable gas reserves are equal to 25 years supply at the 1950 rate of consumption. The report was based on an estimated 102,145 billion cubic feet of gas in Texas and a 1950 production of 4,024,184 million feet. Gas exported totaled 1,341,190 million cubic feet, compared with 421,306 million in 1945. Proved recoverable reserves in Texas increased from 78,807 billion to 102,145 billion between 1945 and 1950, amounting to 54.87 per cent of the U. S. total, the Commission estimated.

Iraq Line Still in Progress

Arabian Bechtel Corporation, 220 Bush Street, San Francisco, California, is laying the 566-mile, 30-in. pipe line for Iraq Petroleum Company from the Kirkuk field in northern Iraq to Banias on the Mediterranean seaboard. Clark Rankin, Bechtel vice president, is project manager.

P. G. & E. Plans Expansion of System

Pacific Gas and Electric Company plans construction of an 8-in. high pressure steel pipe line south from Salinas as far as King City, California, to bring natural gas to Chualar, Gonzales, Soledad, Greenfield, King City, and customers close to the line elsewhere along the route.

T. E. Ward, manager of P. G. and E.'s Coast Valleys Division, Salinas, said the company has filed an application with the California Public Utilities Commission asking authorization to build the line and to exercise franchises already granted the company by the communities.

The project will cost an estimated $1,488,000.

P. G. and E. planned to extend natural gas service to King City immediately after World War II and obtained the necessary franchises, but until now has been prevented from proceeding with the project because it has been continuously unable to obtain pipe in the amount and sizes required. The construction will require 44 miles of 8-in. high-pressure steel pipe for the transmission main and another 32 mi of 2, 3, and 4-in. diameter pipe for distribution lines.

The company finally has obtained the major part of the pipe required and is prepared to begin construction, Ward said. A 9-acre site near Molus Spur, 4½ miles north of Soledad, has been leased by the company for a pipe cleaning and wrapping yard. First shipments of 170,000 ft of pipe were scheduled to begin arriving at the Molus yard the last of April.

P. G. and E. now supplies propane gas to customers in King City from a plant built in 1949. Rates for natural gas service in King City will be lower than those now charged for the propane gas, Ward said. The proposed schedule of rates for the communities served by the new line is being prepared for submission to the Public Utilities Commission.

The new line will extend southward from a connection with an existing 12-in. natural gas main at the P. G. and E. Buena Vista metering station two miles south of Salinas. The 12-in. line connects at the company's Hollister compressor station with the 34-in. Super Inch main transporting Texas and New Mexico natural gas to Northern California and the 20-in. main from Kettleman Hills to the company's Milpitas metering station near San Jose.

Plan Facilities in West Virginia to Expand Storage

United Fuel Gas Company, of Charleston, West Virginia, has asked the Federal Power Commission to authorize the construction of pipeline facilities in West Virginia designed to expand the company's underground natural gas storage operations and transmission facilities to provide capacity sufficiently flexible to meet the demands of its markets.

The proposed facilities, to be situated in Putnam and Kanawha counties, include about 45 miles of natural gas transmission line; a 2640-hp compressor station with dehydration plant, auxiliary units, and appurtenant equipment; and the transfer of one 1000-hp gas engine unit from United Fuel's Walgrove compressor station to its Kanawha compressor station.

Estimated total over-all capital cost of the project is $4,755,830, which would be financed by the issuance and sale of securities to United Fuel's parent company, The Columbia Gas System, Inc.

United Fuel said it now has 10 storage pools in depleted gas fields near its transmission lines and markets, and that it plans to acquire and activate three additional pools in Putnam and Kanawha counties. The application says that no new markets would be served through the proposed facilities.

United Fuel distributes natural gas at retail in West Virginia, Kentucky, and Ohio, and also sells gas at wholesale to companies that operate in West Virginia, Kentucky, Pennsylvania, New York, Ohio, Virginia, and Maryland.

Propose Small Line

Central Kentucky Natural Gas Company, of Charleston, West Virginia, has applied to the Federal Power Commission for authority to construct approximately 18.6 miles of 12¾-in. natural gas pipe line from Winchester to Lexington, Kentucky.

The line, estimated to cost $700,000, would complete the looping of the company's existing 10-in. line from Menifee to Lexington.

The application says that the estimated maximum day operations of the company's existing facilities is 37,300,000 cu ft and the estimated maximum day operations assuming completion of the proposed line, is 58,230,000 cu ft, an increase of 20,930,000 cu ft.

The company said construction was necessary to meet requirements of its present customers during next winter.

Weld Inspection For Pipe Lines

New equipment and services to provide assurance of sound circumferential welds during pipe line construction are announced by Magnaflux Corporation, 5900 Northwest Highway, Chicago 31, Illinois. This is similar to the services used for several years by refineries and drillers.

This Magnetic Particle Inspection method employs local magnetic leakage caused by detrimental defects to attract and hold finely divided ferromagnetic particles in a pattern on the weld surface. This powder pattern builds up as the weld is locally magnetized with high amperage currents, to indicate the exact location, extent, and type of defect. The latest equipment and technique reveals detrimental internal defects such as lack of penetration as well as surface cracks. Defects may be chipped out, rewelded, and reinspected without expensive cutouts and consequent extra labor, it is stated. As the attraction of the particles and the forming of a pattern is a visible phenomena on the weld surface visual inspection can be made simultaneously with Magnaflux inspection. Even on large diameter pipe all circumferential welds can be inspected up to a mile per day.

Application for Sale Of Pipe Line Dismissed

The Federal Power Commission has dismissed the application of State Line Gas Company, of Point Marion, Pennsylvania, which sought authorization to abandon its natural gas pipe line system in Greene and Fayette counties, Pennsylvania, by sale and transfer to The Peoples Natural Gas Company, of Pittsburgh, Pennsylvania.

The commission in a concurrent order dismissed an application by Peoples insofar as it sought authority to acquire the State Line facilities. Peoples' application also asked the commission for a declaratory order that it either is or is not a "natural-gas company" by reason of any operations in which it is now engaged or proposes to engage.

The commission said it was dismissing the part of the Peoples' application relating to the acquisition of the State Line facilities without prejudice to any order or orders heretofore or hereafter entered by the FPC.

In dismissing State Line's application, the commission found that its facilities are not used in the transportation of natural gas in interstate commerce subject to FPC jurisdiction, nor for the sale of natural gas in interstate commerce for resale for ultimate public consumption.

With the PIPE LINE CONTRACTORS

Midwestern Constructors, Inc., 105 North Boulder, Tulsa, Oklahoma, has established central offices at Decatur, Illinois, to handle its several schedules for Texas Illinois Natural Gas Pipeline Company. M. T. Wilhite is general superintendent and A. T. Tolbert is in charge of the office.

Schedule 11 consists of 100 miles of 30-in. from the Mississippi River near Chester, Illinois, to Effiingham, Illinois. There are two spreads on this schedule. One has its field headquarters at DuQuoin, Illinois, with Everett Hart the superintendent, the other at Carlyle, Illinois, with John Work superintendent.

Schedule 12 is 100 miles of 30-in. from Effingham to Sibley, Illinois. Cliff Simmons is superintendent and the field office is at Monticello, Illinois.

Schedule 13 consists of 93 miles of 30-in. from Sibley to Joliet, Illinois. The office is at Morris. Denver Franklin is superintendent.

The crossing of the Illinois River near Morris has been completed.

Installation of piping and certain additions are being made at three of Panhandle Eastern Pipe Line Company's compressor stations, all being about 10 per cent completed the middle of April. At Tuscola, Illinois, F. C. Snavely is superintendent in charge of the work, and Morris D. Garey office manager. At Zionsville, Indiana, J. A. Bard is superintendent and O. J. Casaday office manager. At Edgerton Station, Earl S. Powell is superintendent and H. H. Voss office manager. The field office for this work is situated at Fort Wayne, Indiana.

Anderson Brothers Construction Company, 707 Drennan Street, Houston, Texas, has two spreads at work on 214 miles of 14-in. between Garwood, Texas, and Longville, Louisiana, for Trunkline Gas Supply Company. One spread has its headquarters at Fairbanks, Texas, where Rusty Killingsworth is superintendent, the other at Silsbee, Texas, where Dick Jernigan is superintendent.

Another section for Trunkline is 180 miles between Oak Grove, Louisiana, and Senatobia, Mississippi. With 117 miles to go this work has shut down due to weather and lack of pipe but is expected to get under way again this month.

Contracted with Tennessee Gas Transmission Company are 90 miles of 30-in. between Drew and Holly, Mississippi. This work is scheduled to begin in May. Also for Tennessee, 68 miles of 30-in. will be laid from Horse Cave to Campbellsville, Kentucky. This job has begun.

From Dayton to Cincinnati, Ohio, 58 miles of 8-in. are being laid for the Miami Valley Corporation. Headquarters are at Dayton with Ray Bendure superintendent.

From Toledo, Ohio, to Detroit, Michigan, 90 miles of 26-in. will be laid for Panhandle Eastern Pipe Line Company. The job is scheduled to start in May.

Bechtel Corporation, 220 Bush Street, San Francisco, California, began work in March on a pipe line for General Petroleum Corporation between San Ardo and Estero Bay, California, consisting of 42 miles of 8-in. crude oil line and 42 miles of 4-in. to be used for cutter stock. The project office is at Watson and the field office at San Miguel. J. S. Connell is general manager and George Anderson project manager.

After being held in abeyance awaiting open weather, work is again proceeding on the 409 miles of 30-in. for Texas Illinois Natural Gas Pipeline Company in Arkansas and Missouri. The project office is at 409 East Markham Street, Little Rock, Arkansas. E. W. Davis is division manager, E. J. Hayes division office manager, and E. C. Elting project office manager.

Spread offices are as follows:

Newport, Arkansas, general delivery—B. C. McLean, office man.

Bald Knob, Arkansas, general delivery—Virgil Cobb, superintendent; C. A. Bingaman, office man.

Hope, Arkansas, general delivery—V. L. Williams, superintendent; Harry Sager, office man.

Arkansas River crossing, Box 349, North Little Rock, Arkansas—George Wahlgren, superintendent.

Jackson, Missouri, general delivery—J. E. Richardson, superintendent; E. C. Gavagan, office man.

Bechtel Constructors, Inc., 220 Bush Street, San Francisco, California, began work the middle of April on 120 miles of 24-in. for the Tennessee Gas Transmission Company, between Hamburg, New York, and the Hudson River. The field office is at Richfield Springs, New York, P. O. Box 789. R. L. Bowman is general superintendent and G. H. Homann administrative manager.

O. R. Burden Construction Company, P. O. Box 5216, Tulsa, Oklahoma, is laying 56.6 miles of 10¾-in. pipe for The Texas Pipe Line Company from Lawrenceville, Illinois, to Mount Vernon, Indiana. Pete Hiner is spread superintendent.

Work is scheduled for May on the Platte Pipe Line Company job. Burden has the contract to lay 280 miles of this system, his section being between the Missouri River near St. Joseph, Missouri, and the Mississippi River near Wood River, Illinois.

Considerable work is being done in Texas for Service Pipe Line Company and The Texas Pipe Line Company. For Service, 183 miles of 8-in. and 40 miles of 6-in. are being taken up between Dallas and Fort Worth, Fort Worth and Chico, and Ranger and Fort Worth. Between Sherman and Armstrong, Texas, 52 miles of 6-in. are being taken up for Texas Pipe Line.

Vaughn and Taylor Construction Company, Inc., P. O. Box 1351, Wichita Falls, Texas, is constructing a 165-mile gathering system in Sherman County, Texas, for Phillips Petroleum Company. Diameter of the pipe is 3 in. through 12 in.

A gathering system also is being laid for Sunray Oil Corporation. This one is in the Snyder field, Texas, and consists of 138 miles of 3 in. through 20 in. pipe.

Brown and Root, Inc., P. O. Box 3, Houston, Texas, has been awarded a contract by United Gas Pipe Line Company covering various phases of engineering, construction, and other services on more than 1000 miles of pipe line that will be laid in Texas, Louisiana, and Mississippi.

Since February 15, this contractor has been at work on another project for United. This consists of 88.7 miles of various size pipe from 6⅝-in. to 16-in. from the West Bay field, Plaquemines Parish, Louisiana, to New Orleans. The field office is at Harvey. J. W. Kincy is superintendent and T. M. Strong office manager.

Bishop and Lock, 503 Magnolia Building, Dallas, Texas, is still awaiting the arrival of pipe to begin work on the Platte Pipe Line Company job. Work was expected to begin sometime in May but there is some possibility of further delay. The contractor will lay a 142-mile section from Marysville, Kansas, to Holdrege, Nebraska.

How to Keep a Pipe-Line from Getting Restless...

USE

BARAWATE

THE SPECIALLY-GROUND BARYTES

HIGHLIGHTS on BARAWATE

High specific gravity gives concrete densities as high as 210 lb. cu. ft.

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Chemically inert—reduces corrosion problem.

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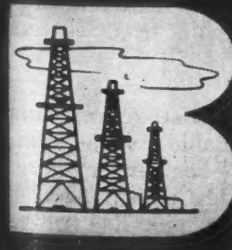
Easy to apply. Available in bulk or in 100 lb. paper sacks.

for HEAVIER Pipe-Weighting Concrete

Although BARAWATE is fairly new in the field, pipe line contractors are already saying that it's a real answer to the problem of keeping under-water, or marsh-laid, pipe lines in place against the effects of waves, tides, shifting silt, freezing or thawing.

BARAWATE is specially-crushed high-grade barytes, used as an aggregate in high-weight concrete. Because of BARAWATE'S high specific gravity—4.3—BARAWATE concrete may be made as much as *60% heavier than ordinary concrete.* Densities as great as 210 lbs. cu. ft. are possible. From the economic angle, it has been reported that BARAWATE concrete represents a saving of more than $5.00 a linear foot on 24-inch pipe when measured against the cost of cast iron weights or anchors necessary to do the same job.

BARAWATE concrete coatings may be applied over reinforcing steel either pneumatically or mechanically, or may be precast for river clamps. Since barytes is chemically inert, BARAWATE concrete reduces the chances of corrosion: BARAWATE concrete coatings also protect the inner line coatings against attack by barnacles, teredos and other marine organisms.



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H. C. Price Company, Pipeline Division, Box 1111, Bartlesville, Oklahoma, has the general contract covering construction of approximately 156 miles of 24-in. high pressure natural gas pipe line for Tennessee Gas Transmission Company between Hamburg, New York, and Onondaga-Madison county line, New York. Right-of-way work began May 1. Spreads are situated as follows:

Auburn, New York: G. A. Reutzel, superintendent; W. E. Yount, office manager, and the following foremen: J. A. Hairston, right-of-way; L. J. Loncarich, ditch; J. C. Anderson, bending; H. C. Morrison, pipe; K. N. Adkins, pipe; R. W. Orr, welding; S. J. Wood, coating; A. L. Bell, lower-in; T. E. Walker, clean-up.

Warsaw, New York: R. K. Shivel, superintendent; W. R. Crego, office manager, and the following foremen: J. D. White, right-of-way; W. H. Olrich, ditch; J. H. Latham, bending; Delbert Shivel, pipe; R. L. Ezell, welding; Sam Price, clean-up; C. W. Sisco, lower-in; J. B. Northcutt, coating.

Another contract covering construction of approximately 200 miles of 30-in. high pressure natural gas pipe line for Texas Illinois Natural Gas Pipeline Company from Trinity River northeastward to the Texas-Arkansas state line near Texarkana. Began laying pipe April 4. Spreads are as follows:

Carthage, Texas; telephone 1138: C. E. Shivel, superintendent; D. H. Johnston, office manager, and the following foremen: R. H. Edwards and Paul McCormick, right-of-way; Ray Drewell, ditch; J. V. Huff, bending; E. D. Worley, pipe; C. F. Jones, welding; Henry Hill, coating; Bill Buchanan, lower-in.

Nacogdoches, Texas, general delivery, telephone 2198: C. R. Ice, superintendent; G. A. Harvey, office manager, and the following foremen: John E. Hamilton and Jessie Cash, right-of-way; E. W. Whisenant, ditch; Forest Loinette, bending; W. T. Dickerson, pipe; L. O. Reutzel, welding; N. D. Adams, coating; J. C. Rich, lower-in.

H. C. Price Company, Somastic Division, Bartlesville, Oklahoma, has the following jobs:

Philadelphia plant operations:

Allentown-Bethlehem Gas Company—Application of Somastic coating to 14,500 ft of 12¾-in. OD pipe.

General Electric Company—Application of coating and internal cleaning and coating to 20,000 ft of 6⅝-in. OD pipe.

Okonite-Callender Cable Company, Inc.—Application of coating and internal cleaning and coating to 31,100 ft of 6⅝-in. OD pipe; 25,700 ft of 5 9/16-in. OD pipe.

Phelps-Dodge Corporation—Application of coating and internal cleaning and coating to 11,000 ft of 5 9/16-in. OD pipe.

Philadelphia Electric Company — Application of coating to 500 ft of 20-in. OD pipe; 80,000 ft of 16-in. OD pipe.

Philadelphia Gas Works Company —Application of coating to all pipe requirements from 1¼-in. to 30-in. for 1951.

Sun Oil Company—Application of coating to 4200 ft of 10¾-in. OD pipe; and 6,300 ft of 12¾-in. OD pipe.

At Staten Island, New York:

Transcontinental Gas Pipe Line Corporation—Application of Somastic coating to 71,000 ft of 26-in. OD pipe; 16,000 ft of 24-in. OD pipe and application of 3-in. Hevicote to 16,000 ft of 24-in. OD pipe.

New Orleans plant operations—(At Morgan City, Louisiana):

Gulf Southern Contractors (for United Gas Pipe Line Company)—Application of Somastic coating to approximately 26.3 miles of 30-in. OD pipe; 23.8 miles of 26-in. OD pipe; 24.6 miles of 24-in. OD pipe; 15.5 miles of 20½-in. OD pipe; 21.1 miles of 20-in. OD pipe; 13.4 miles of 16-in. OD pipe; and 12.3 miles of 14-in. OD pipe.

Somerville Construction Company, Ada, Michigan, began work in April on 20 miles of 20-in. for Ohio Fuel Gas Company, from New Albany to Homer, Ohio. Harold Cook is spreadman.

Mahoney Contracting Company, 2300 North Grand River, Lansing, Michigan, has resumed work on the Trunkline Gas Supply Company job after having been shut down during the winter. Barney Finnerty is in charge. The field office is at Flora, Illinois, the phone number 647. For Trunkline, 100 miles of 26-in. is being laid from Flora to Joppa, Illinois.

The company recently contracted to lay two water crossings in Venezuela for Shell Caribbean Petroleum Corporation. One is a 10-mile, 20-in. crossing of Lake Maracaibo, the other a 4-mile, 30-in. crossing of the Gulf of Coro. Angelo Tavernaro will be in charge.

The laying of 36 miles of 20-in. began the middle of April for Texas Eastern Transmission Corporation. The line is between Connellsville, Pennsylvania, and the Oakford storage area. Henry Mogg is superintendent in charge of the work.

Houston Contracting Company, 2707 Ferndale Place, Houston, Texas, has the following construction work under contract:

Approximately 158 miles of 30-in. gas line for Tennessee Gas Transmission Company. This work consists of four sections extending from the vicinity of Jones, Louisiana, on the north to near Cypress, Texas, on the south. Work will be done by three spreads as follows:

One spread will handle the north end of the work and will have its headquarters at Bastrop, Louisiana. W. H. Hayes, superintendent; M. L. Thompson, assistant superintendent; J. C. Strickler and J. B. Stoddard, office. Preliminary right-of-way work began late in April.

One spread will handle the center section and will be at Natchitoches, Louisiana. E. C. Norris, superintendent; R. E. Thornton, assistant superintendent; R. J. Axsom, office. Began laying pipe May 1.

One spread will handle the south end and will work out of Conroe, Texas. F. A. Silar, superintendent; C. V. Oliver and L. F. Redfearn, office. Pipe laying began about April 20.

Approximately 42 miles of 10-in. gas line for Humble Oil and Refining Company from Anahuac gasoline plant near Anahuac, Texas, to Gulf States Utilities plant near Beaumont, Texas. J. A. Cantrell, superintendent; J. B. Stoddard, office; present headquarters, Winnie, Texas. Work has started at the Anahuac end.

Approximately 12½ miles of 12-in. gas line for Dow Chemical Company from the vicinity of Bay City, Texas, to Sweeny meter station. H. L. Leake, superintendent; S. B. Harrison, assistant superintendent; H. E. MacWhinnie, office; headquarters, Bay City, Texas. Work has begun.

Western Pipe Line Constructors, Inc., Lockhart Building, Austin, Texas, has contracted to lay 121 miles of 30-in. pipe line for the Tennessee Gas Transmission Company as part of its new expansion program. In addition, three major river crossings will be installed, the Duck, Buffalo, and Tennessee. Two spreads are at work. One is laying 59 miles between Parsons and Dickson, Tennessee, and the other 62 miles from near Richmond to a point near Salt Lick, Kentucky.

Conyes Construction Company, 2884 San Pablo Avenue, San Pablo, California, has under construction for Ohio Oil Company, 180 miles of 20 and 22-in. pipe line between Carloa, Indiana, and Vandalia, Illinois. Jimmy Allman is superintendent.

H & L TOOTH CO.

(Pioneer Manufacturers of Two-Part Teeth)

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DEALERS

ALABAMA
Birmingham & Montgomery
Leary & Owens Machinery Co.

ARIZONA
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Equipment Sales Company

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Clark Equipment Company

CALIFORNIA
San Francisco, Sacramento
Edward R. Bacon Company
Bakersfield
Hopper Machine Works, Inc.

COLORADO
Denver
Heiner Equip. & Supply Co.

FLORIDA
Miami
Llewellyn Machinery Co.

GEORGIA
Atlanta & Macon
Tri-State, Inc.
Albany
Tri-State Tractor Company

IDAHO
Boise & Idaho Falls
Western Equipment Company

KENTUCKY
Louisville & Lexington
Bogie Equipment Co.

MASSACHUSETTS
Needham Heights
Genalco, Inc.

MISSOURI
St. Louis
John Fabick Tractor Company

MONTANA
Butte, Billings, Great Falls
Hall-Perry Machinery Co.

NEW MEXICO
Albuquerque
Contractors' Equipment & Supply Company

OKLAHOMA
Tulsa
Perrault Bros., Inc.

OREGON
Portland
Howard-Cooper Corp.

PENNSYLVANIA
Pittsburgh
Atlas Equipment Corp.

SOUTH CAROLINA
West Columbia
State Machinery & Supply Co.

TENNESSEE
Knoxville & Nashville
Dempster Bros., Inc.
Memphis
Tri-State Equipment Company

TEXAS
Dallas
Shaw Equipment Company
El Paso
Contractors' Equipment & Supply Company
Houston
Browning-Ferris Machinery Co.
Lubbock
Fred Berryhill Equipment Co.

UTAH
Salt Lake City
Heiner Equipment & Supply Company

VIRGINIA
Roanoke
J. W. Burress

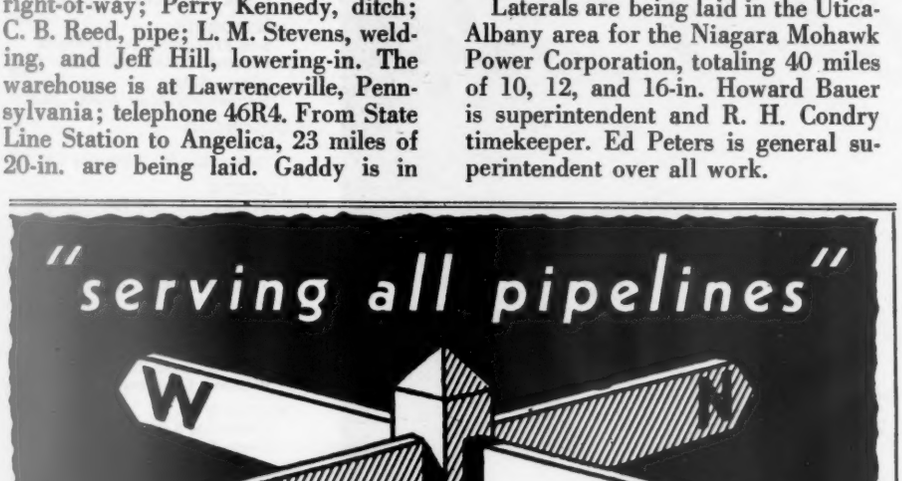
WASHINGTON
Seattle
Howard Cooper Corp.
Spokane
Western Equipment Company

CANADA
Vancouver, B. C.
Rollins Machinery, Ltd.

▸ **Williams-Austin Company,** Grant Building, Pittsburgh, Pennsylvania, has three spreads working on the New York State Natural Gas Corporation project. Right-of-way clearing has begun on all three. Between Boom storage field and Ithaca, New York, 37 miles of 20-in. are being laid. Ralph Gaddy is superintendent. The following are foremen: D. L. Swartz, right-of-way; Perry Kennedy, ditch; C. B. Reed, pipe; L. M. Stevens, welding, and Jeff Hill, lowering-in. The warehouse is at Lawrenceville, Pennsylvania; telephone 46R4. From State Line Station to Angelica, 23 miles of 20-in. are being laid. Gaddy is in charge of this work also. The warehouse is at Wellsville, New York.

Between Utica and Ithaca, New York, 82.5 miles of 20-in. are being laid. Leman Creech is superintendent and L. A. Frabks timekeeper. The following are foremen: Joe Levan, right-of-way; Jesse Hunnell, pipe; E. J. Roth, welding; O. L. King, clean-up, and Arley Peacher, lowering-in.

Laterals are being laid in the Utica-Albany area for the Niagara Mohawk Power Corporation, totaling 40 miles of 10, 12, and 16-in. Howard Bauer is superintendent and R. H. Condry timekeeper. Ed Peters is general superintendent over all work.



PIPELINE COATINGS

and

WRAPPING MATERIALS

S. D. DAY COMPANY

1973 WEST GRAY HOUSTON, TEXAS PHONE JU-2431

▸ **Gulf Southern Contractors,** 804 Dan Waggoner Building, Fort Worth, Texas, has been awarded a $25,000,000 contract by the United Gas Pipe Line Company of Shreveport, Louisiana. The contract calls for the construction of 1000 miles of pipe line in Louisiana, Texas, and Mississippi, and, in addition, the laying of a 20-in. line approximately 15 miles into the Gulf of Mexico from the Louisiana coast.

Gulf Southern is a contracting group composed of **Texas-Louisiana Contractors** of Fort Worth, **Oklahoma Contracting Company** of Dallas, **J. Ray McDermott and Company, Inc.,** of New Orleans, and **Morrison-Knudson Company, Inc.,** of Boise, Idaho.

▸ **Oklahoma Contracting Company,** 1210 Mercantile Bank Building, Dallas, Texas, is completing the 65 miles of 26 and 30-in. loops it has been laying for Tennessee Gas Transmission Company near Falfurrias and Victoria, Texas. Headquarters are at Falfurrias with Panama Shifflet in charge.

Pipe was scheduled for receipt about May 1 on the job for Tennessee Gas in the East. From the Hudson River just south of Albany, New York, to a point near Wilmington, Massachusetts, 175 miles will be laid for Tennessee Gas and its subsidiary, Northeastern Gas Transmission Company. Right-of-way and ditching operations have been under way since April 1. Pipe laying will be handled by three spreads. The spread in charge of H. A. "Red" Wylie has its headquarters at Pittsfield, Massachusetts. The one under Aldress Kilgore is working from Westfield, Massachusetts, and the spread in charge of L. B. Rea has its headquarters at Sudberry, Massachusetts. Headquarters for the entire job are at Springfield, Massachusetts. Paul R. Halbert is in charge and Harry Prindle is his assistant.

▸ **Associated Pipe Line Contractors, Inc.,** P. O. Box 2163, Houston, Texas, has under construction 121 miles of 16-in. pipe line for Southern Natural Gas Company. The pipe is being laid between Tuskegee, Alabama, and Macon, Georgia. Lacy Walker is superintendent and Buck Johnson field office manager.

▸ **Williams Brothers-Davis Company,** 6006 Jensen Drive, Houston, Texas, has been awarded a contract by Texas Eastern Transmission Corporation for construction of 163.6 miles of 30-in. between Kosciusko, Mississippi, and the Tennessee River.

▸ **Dunn Brothers,** 801 Mercantile Securities Building, Dallas Texas, are stringing pipe for H. C. Price Company on the Texas Illinois Natural Gas Pipeline Company project, as follows:

Section 4—109 miles of 30-in. from Glenflora to Urbana, Texas.

Section 5—91 miles of 30-in. from Urbana to Dotson, Texas.

Section 6—99 miles of 30-in. from Dotson to the Texas-Arkansas state line.

Other jobs being strung by the company are as follows:

El Paso Natural Gas Company — 415 miles of 24-in. between Fruitland, New Mexico, and Yucca, Arizona. (San Juan line.)

El Paso Natural Gas Company — 419 miles of 30-in. in New Mexico, Texas, and Arizona.

Tennessee Gas Transmission Company, between 400 and 500 miles from Buffalo, New York, to the Massachusetts border.

▸ **Knupp Construction Company, Inc.,** Great Bend, Kansas, is laying 29 miles of 16-in. pipe for Cities Service Gas Company between Hesston and Wichita, Kansas, and taking up 66 miles of 6, 7, 8, and 10-in. between Hutchinson and Wichita. The field office for both jobs is at Newton. Cliff Harris is spreadman and Paul Starbuck office manager.

▸ **R. H. Fulton and Company,** P. O. Box 1526, Lubbock, Texas, will lay Platte Pipe Line Company's line from Chatham station in Wyoming to Brule, Nebraska, approximately half of the 1072-mile system. The work originally was expected to start in May, but there now seems to be question about pipe deliveries.

Fulton also is laying 56 miles of 12¾-in. crude oil line for The Texas Pipe Line Company between the Chico station in Wise County, Texas, and Wichita Falls. The field office is at Henrietta, where M. L. Boyd is superintendent and C. E. Helwig office manager.

For Trunkline Gas Supply Company, the 184-mile section of 26-in. from Senatobia, Mississippi, to Joppa, Illinois, is being laid. The field office is at Memphis, Tennessee. Ed Veach is spread superintendent and Bill Gray office manager. Clark Williams is general superintendent.

For Northern Natural Gas Company, 155 miles of 20-in. is being laid between Jetmore and Bushton, Kansas, and 73 miles of 26-in. from Concordia to Salina, Kansas. Jerry Nash is in charge of the former job and M. L. Boyd of the latter.

As a joint venture, R. H. Fulton and J. T. Brodie are laying 264 miles of 20-in. for Trunkline Gas Supply Company between McAllen and Altair, Texas. The field office is at Victoria. J. T. Brodie is in charge. Bill Fenn is spreadman.

▸ **Brown Lite Company,** Tulsa, Oklahoma, and Arey-Phillips Construction Company, Pampa, Texas, as a joint venture, are laying 278 miles of 10-in. crude oil line for Phillips Petroleum Company, from Phillips, Texas, to Yale, Oklahoma. Weather and other conditions permitting, the job is expected to be completed about June 1.

▸ **Texas-Louisiana Contractors,** 804 Dan Waggoner Building, Fort Worth, Texas, is finishing up 50 miles of 20-in. for United Gas Pipe Line Company to serve the Dow Chemical Company plant at Freeport, Texas. The line originates in the vicinity of Rosenberg.

▸ **Western Pipe Line Coating Company, Inc.,** P. O. Box 1063, Wichita Falls, Texas, is coating 135 miles of 10-in. pipe for Brown Lite Company of Tulsa, Oklahoma. The pipe is being laid between Yale and Clinton, Oklahoma, for Phillips Petroleum Company. Cecil D. Carey is general superintendent.

THE PIG WITH THE POKE — CLEANS PIPE LINES

THE VERY LATEST

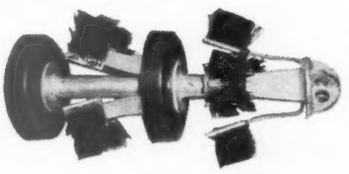
Williamson Pipe Line Pigs*

FOR CLEANING

NATURAL GAS PIPE LINES

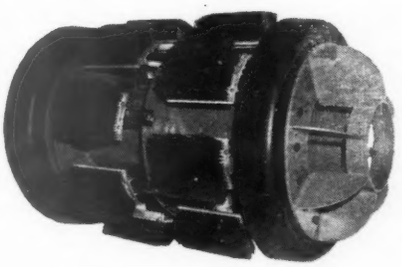
4" Size—TYPE JRN—2" to 4" sizes will pass 1½ R-90° Bends. No valves other than full diameter thru port valves.

Use TYPE SCN-51 for 6" size.



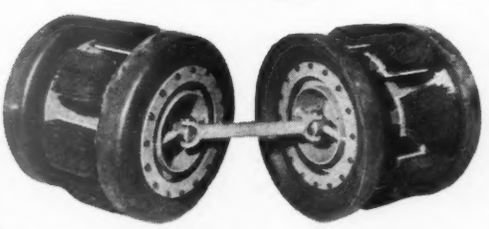
8" Size—TYPE WC-11—8" to 14" will traverse 6 foot radius field bends, full diameter side openings at 45°.

SPRINGS COMPENSATE for BRUSH WEAR.



20" Size—TYPE GP-2—16" to 30" 200 lb. SPRING forces the brushes against pipe wall—COMPENSATING for WEAR. Will traverse round opening gate or plug valves.

SPRINGS and BRUSHES are identical and interchangeable for all types and sizes of GP-PIGS.



24" Size—GP-3—18" to 30" sizes will pass 1½ R-30° bends. SPRINGS COMPENSATE for BRUSH WEAR ASSURING full section cleaning efficiency. GP-3 consists of two Type GP-1 Pigs. Each unit may be used as individual pig.

Patents Pending

T. D. Williamson, Inc.

TULSA 9, OKLAHOMA

EXPANSIBLE FLUID-ACTUATED PIPELINE CLEANERS

The Best Advertisement Past Performance

Now being used on over 10,000 miles of large diameter gas transmission lines by some of the largest companies.

Advantages Essential for a Thorough Pipeline Cleaning Program—12-Inch Through 30-Inch

(Also 6", 8" and 10" Available Soon)

EXPANSIBLE

Will not get stuck in heavy walled crossings. Constant pressure by brushes against the entire circumference, top, sides and bottom. Expands to compensate for brush wear. Tight fit at all times insures a perfect cleaning job.

VARIABLE

Brushes (or working surfaces) are double that of other cleaners—brushes can be interchanged to meet any conditions—fine, medium or coarse wire brushes—also steel scrapers. Fits any job.

FLEXIBLE

Goes around side bends, over bends, or sags. Does not get caught by sidetaps or drops to drips or slowed by chill rings.

EFFICIENT

Do not lose the additional revenue that can be obtained from thoroughly cleaning your transmission lines. The increased efficiency (more sales volume with the same facilities) pays for the cost of cleaning in from one to six months. Order now for summer cleaning program.

CLEANER PIPELINES COMPANY

1900 Armour Road

North Kansas City 16, Mo.

▸ **Williams Brothers Company,** National Bank of Tulsa Building, Tulsa, Oklahoma, is working two spreads on the Plantation Pipe Line Company job. A field office has been opened at Talladega, Alabama, on the section from Baton Rouge, Louisiana, to Bremen, Georgia, 432 miles of 18-in. Thelma Davis is superintendent of this spread. The other spread is working out of Tuscaloosa, Alabama, with O. L. "Whitey" Martin the superintendent. This section, between Bremen and Charlotte, North Carolina, consists of 275 miles of 14-in.

In Venezuela, 195 miles of 10, 12, and 16-in. pipe are being laid for the Venezuelan Atlantic Transmission Corporation from Las Mercedes to Caracas. Headquarters are at the latter point with Marvin E. Jones the superintendent.

From Palmerejo, near Maracaibo, to Punta Cardon, Venezuela, 160 miles of 30-in. are under construction for the Shell Caribbean Petroleum Company. Marvin Jones also is in charge of this work.

▸ **Latex Construction Company of Georgia,** Northside Branch, Box 56, Atlanta, Georgia, is doing the pump station and terminal work involved in Plantation Pipe Line Company's expansion program. Station buildings are being enlarged at Baton Rouge, Louisiana; Collins, Mississippi; Akron and Silver Run, Alabama; Bremen and Center, Georgia, and Spartanburg, South Carolina. Terminals will be enlarged at all main points between Baton Rouge and Charlotte, North Carolina.

▸ **H. L. Gentry Construction Company,** 921 East Michigan Avenue, Jackson, Michigan, will complete about May 15 the 55 miles of 12¾-in. being laid for Southeastern Michigan Gas Company between Birmingham and Port Huron, Michigan. Frank Morris is superintendent.

Jim Mitchell is in charge of city work being done in Toledo, Ohio, for the Ohio Fuel Gas Company. The pipe is of various size and completion date is indefinite.

▸ **Rumsey Brothers Pipe Line Construction Company,** M. and M. Building, Houston, Texas, will construct 100 miles of Platte Pipe Line Company's system, the section from the Nebraska-Kansas state line, near Lanham, Kansas, to the Missouri River, near Doniphan, Missouri. The job has not yet started. Al Works will be in charge as superintendent with Walter A. Hale managing the field office.

A Self-Propelled Tractor-Compressor Combination of Many Uses

SCHRAMM *Pneumatractor* LENDS VERSATILITY TO PIPELINE CONSTRUCTION

When you're battling against time . . . and the terrain is tough, you pipe line contractors can call on the Schramm ***Pneumatractor,*** with auxiliary equipment, for a wide variety of uses . . . Rock Drilling, Backfilling, Earth Moving, Timber Sawing, Removing Rock and Debris from the Ditch – Snow Plowing in northern areas. Your own ingenuity will suggest many others. And, of course, wherever you use air, the ***Pneumatractor*** is your dependable, economical and completely mobile supply.

The Schramm ***Pneumatractor*** is a self-propelled tractor-compressor combination that has the versatility pipe line constructors require. It is efficient, rigidly built, with adjustable rear wheels, tilting front axle, front or rear power take-off, and tractor-type air cleaners for severe service under all conditions.

The engine-compressor is the Schramm ***Pneumapower,*** having many features not available in any other self-propelled unit.

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Whether your crews are working on a local or transcontinental job, in this or any foreign country, you can readily obtain a complete assortment of service parts in a compact repair part kit without a big investment or inventory. Schramm maintains a worldwide organization, with dealers in all important distributing centers. You are sure of up-to-the-minute service always.

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The Compressor People
West Chester, Pa.
SEND FOR BULLETIN NEU-50-B.

Name.....
Company.....
Street.....
City.....Zone.....State.....

PIPELINE PERSONALS

▸ **F. C. Davis** has been elected a vice president of the Charleston Group Companies. He has been chief engineer of the compressor department of the United Fuel Gas Company and will continue to direct its compressor activities, as well as those of the other companies in the group.

John W. Partridge, assistant to the president of the Charleston Group Companies, has been made a director.

Other organization changes included: **Ira Good,** former chief gas dispatcher for the companies, was promoted to the duties of superintendent of operations of the Charleston division.

C. E. Pettry, assistant chief gas dispatcher, was promoted to chief gas dispatcher, assuming the former duties of Good.

E. C. Stump, formerly superintendent of the gas storage department, assumes the duties of superintendent of gas procurement.

John H. Kime, gas storage engineer, was made superintendent of the gas storage department, assuming the duties formerly carried out by Stump.

C. E. Stout, formerly manager of the geological and gas depletion department, becomes manager of geology and storage.

Roger D. Stanwood

▸ **Roger D. Stanwood,** formerly with Tide Water Associated Oil Company for 11 years and recently assistant superintendent of its gas utilization department, has accepted the position of assistant to the vice president of gas supply of Transcontinental Gas Pipe Line Corporation. A native of Boston, Massachusetts, Stanwood graduated from Dartsmouth College in 1939 and is a member of AIME. His headquarters will be in Houston, Texas.

▸ **N. B. Mavris,** engineer in the Tulsa office of Interstate Oil Pipe Line Company, presented a paper entitled "Economics of Increasing Capacities of Pipe Line Systems" before the April 16 meeting of The Pipe Liners Club of Tulsa.

▸ **A. W. Bredlow** has been made superintendent of Standard Oil Company's marine and filling racks division at Whiting, Indiana, according to an announcement by **J. C. Ducommun,** manager.

Other appointments in the same department include **D. V. Hartzell** to assistant superintendent; **George Fraser** to general foreman, and **Joseph Windhauser** to assistant general foreman.

Bredlow began his employment with the Standard Oil Company in Whiting, April 23, 1918, as a helper in the light oils division. In 1919 he was promoted to dock superintendent in the division he now heads. He became manager of the lake terminal in Muskegon, Michigan, in 1922 and seven years later manager of the River Rouge terminal. He returned to Whiting, July 1, 1939, as assistant superintendent, the position he held until his present promotion.

The new assistant superintendent, D. V. Hartzell, began his employment in the service department of the Whiting refinery, March 16, 1934. He entered the marine and filling racks division in 1936 as a clerk and became assistant general foreman, May 1, 1943.

General foreman George Fraser was promoted from the heavy oils division where he was assistant general foreman of the extraction and treating department. **H. C. Scott** has been transferred to that position from assistant general foreman of the stills and labor department. **J. G. Walker** has been promoted to assistant general foreman, stills and labor department, from shift foreman and **A. N. Groves,** stillman, has been promoted to shift foreman.

Joseph Windhauser, new assistant general foreman of the marine and filling racks division began his employment with the company at the Green Bay lake terminal and was promoted to marine dispatcher at Whiting, March 1, 1947, the position he has held to this present promotion.

▸ **John W. Kelley** has succeeded **Clyde D. Alstadt** of Lexington, Virginia, as vice president of the Atlantic Seaboard Corporation and Virginia Gas Transmission Corporation. He also has been elected a director of these two companies. Alstadt has been transferred to the Columbia Engineering Corporation and will have his headquarters in Columbus, Ohio. Kelley has been general superintendent of United Fuel Gas Company.

Jack Clarke

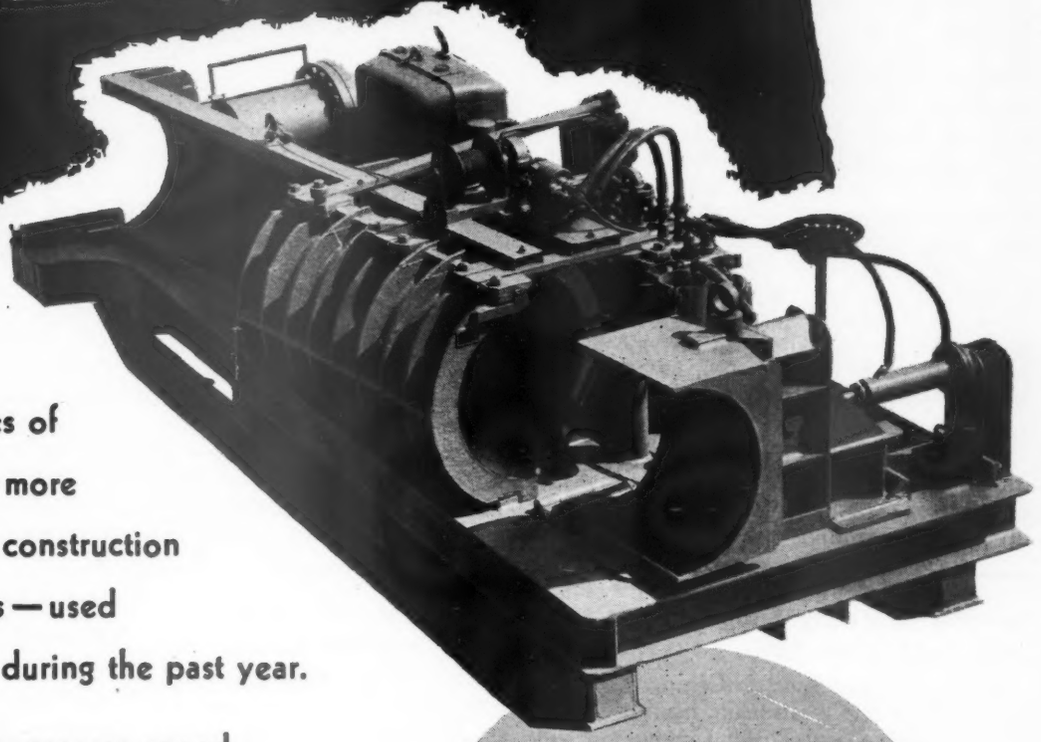
▸ **Jack Clarke** has been appointed director of public relations for Texas Eastern Transmission Corporation, **George T. Naff,** executive vice president of the company announces. Clarke will supervise all public relation activities of the corporation, including financial and stockholder relations, publications, and advertising.

Clarke was formerly assistant to the chairman of the board of Lion Oil Company, El Dorado, Arkansas, where he was in charge of public relations. He has been closely associated with the oil and gas industry since January, 1938, when he joined Lion Oil Company's budget-statistical department. He became manager of this department in 1941 and later was assistant to the president.

As a naval officer for almost four years during World War II, Clarke served in all three theaters of war but principally in the Pacific where he participated in the initial Leyte and other invasions. Since the war he has been active in oil industry organizations, including the National and Arkansas Oil Industry Information Committees of the American Petroleum Institute, the Texas Mid-Continent Oil and Gas Association, and the Independent Petroleum Association of America.

Clarke was born in Abingdon, Virginia, in 1914. He is a graduate of Williams College and a member of Phi Delta Theta. He also attended the Graduate School of Business Administration of New York University. He and Mrs. Clarke, the former Dorothy Irelan of Forest Hills, New York, will make their home in Shreveport, Louisiana, where the general offices of Texas Eastern are situated.

CINCH Pipe Bender used on more than half of smooth Big Inch construction in past twelve months



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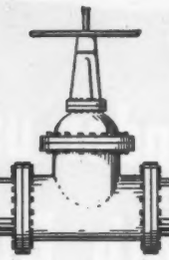
PIPE LINE PROJECTS



Louisiana to Indiana 680-Mile Gas Line Proposed

Gulf-Michigan Gas Transmission Corporation, St. Louis, Missouri, has applied to the Federal Power Commission for authority to construct a 680-mile Louisiana-to-Indiana natural gas pipe line for service to Michigan-Wisconsin Pipe Line Company, with a lateral line to the St. Louis area.

The proposed project, estimated to cost $85,000,000, would initially transport 350,000,000 cu ft of natural gas daily from southern delivery points of supply to northern and intermediary markets, the application states. The company plans to deliver 200,000,000 cu ft daily to Michigan-Wisconsin, with the remaining 150,000,000 cu ft going to the St. Louis area.

The main 680-mile, 30-in. line would extend from Perryville, Louisiana, across Arkansas, Missouri, and Illinois to a terminus near St. John, Indiana, where it would connect with Michigan-Wisconsin's facilities. The St. Louis lateral would extend from a point near Belleville, Illinois, for approximately 25 miles west to the east bank of the Mississippi River opposite St. Louis. The system would be powered by three compressor stations of approximately 30,800 total horsepower.

Gulf-Michigan, which is a new corporation, plans to begin construction of the project in March, 1952, and to complete the job in November of that year.

The gas supply for the proposed system would be obtained initially from the United Gas Pipe Line Company, the application says. Gulf-Michigan said it is in the final stages of negotiation for the purchase of 360,000,000 cu ft a day, to be delivered at a point of connection near Perryville.

A 172-Mile Gas Line Asked for Pennsylvania

The Manufacturers Light and Heat Company, of Pittsburgh, Pennsylvania, has filed an application with the Federal Power Commission in connection with the proposed construction of 172 miles of pipe line, which would be used to deliver gas from producing fields in Clinton County, Pennsylvania, and vicinity into the Pittsburgh area.

The proposed project, estimated to cost $9,613,000, would include 172 miles of 16, 20, and 24-in. pipe, together with measuring stations and river crossings, extending from a point in Gallagher Township in Clinton County to a point northwest of Cannonsburg in Washington County, Pennsylvania.

The company estimates that the theoretical maximum capacity of the proposed line would be approximately 105,000,000 cu ft a day.

Greater Capacity Sought Topock-Milpitas Line

Pacific Gas and Electric Company, of San Francisco, California, has applied to the Federal Power Commission for authority to construct facilities that would increase the capacity of its Topock (Arizona) — Milpitas (California) pipe line by approximately 150,000,000 cu ft of natural gas a day.

The proposed facilities, estimated to cost $19,391,000, include parallel sections of 34-in. pipe, aggregating approximately 141 miles, along the existing Topock-Milpitas line, and the addition of 22,780 hp in compressor capacity at authorized stations.

The company said the additional capacity is needed to meet the load growth in its existing service area, which includes 28 counties in central and northern California. The additional gas will be received from El Paso Natural Gas Company. El Paso now has two applications pending before the FPC for the construction of facilities to supply this gas to PG and E.

PG and E is now authorized to receive 400,000,000 cu ft of gas a day from El Paso for transportation through the Topock-Milpitas line.

Texas-New Mexico Plans Pipe Line in West Texas

Texas-New Mexico Pipe Line Company will extend its facilities to provide a crude oil outlet of approximately 75 miles of 8-in. pipe line from the new producing areas in the Midland County, Texas, Basin, it was announced by R. B. McLaughlin, president of the company.

Preliminary plans on the project are being formulated by the company. Part of the construction work will be started soon and the remainder will be undertaken when line pipe and equipment are available.

The extensions will include an 8-in. pipe line from Midland into the Germania pool. The company also plans construction of an 8-in line from Midland to serve the Scarborough area and to connect with the Sweetie-Peck area in Midland County, Texas, and an 8-in. extension from the company's Crane station to the new sweet crude production in the McElroy area.

In addition, an 8-in. sweet crude gathering system will be extended from the existing facilities at Eunice, New Mexico, to the Lovington and Saunders areas in Lea County, New Mexico, a distance of approximately 55 miles.

Atlantic Seaboard Plans New Compressor Station

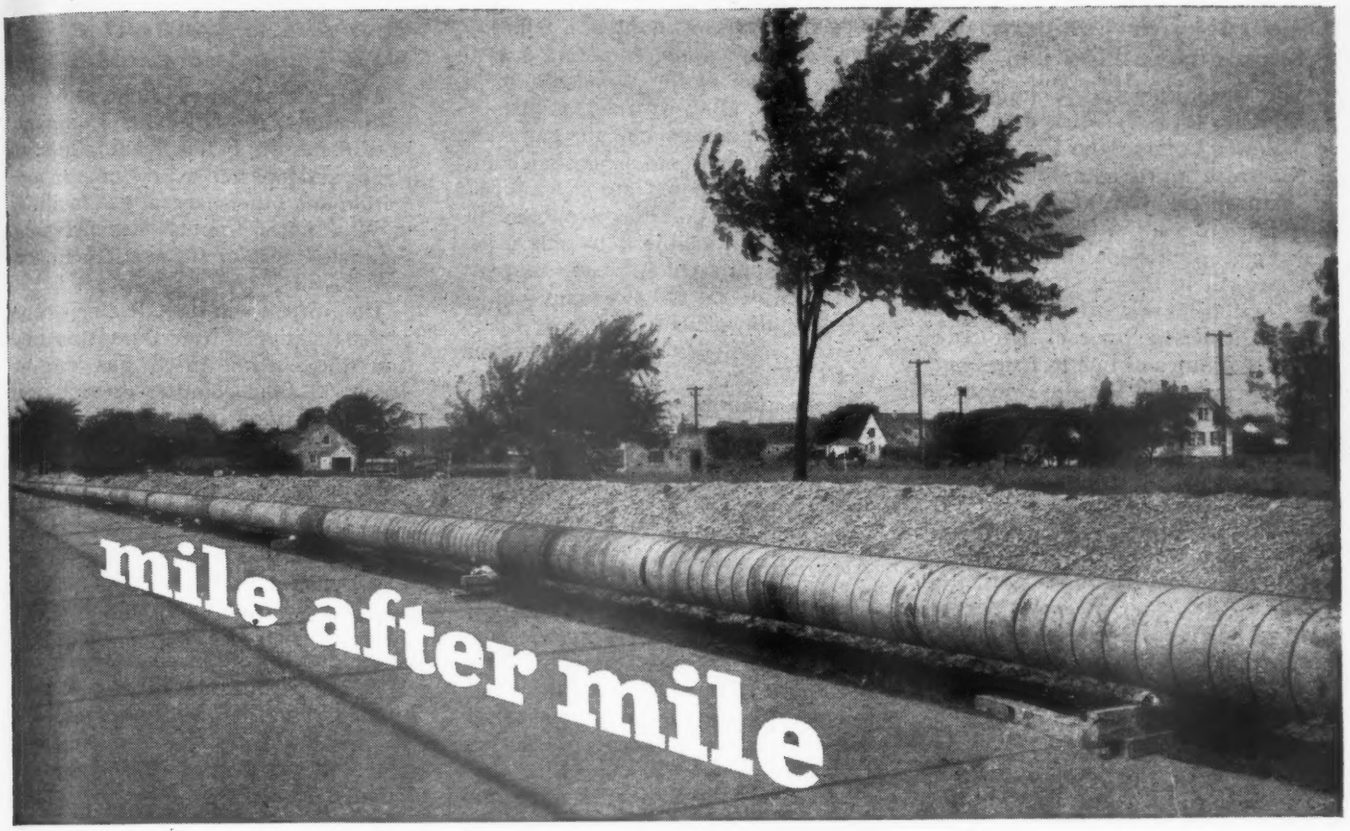
Atlantic Seaboard Corporation, of Charleston, West Virginia, has applied to the Federal Power Commission for authority to construct a 3520-hp compressor station in Randolph County, West Virginia, on its Cobb-Rockville 26-in. line to provide additional capacity sufficient to meet the 1951-52 peak day and winter volumes of its present natural gas customers.

The proposed new station would contain four 880-hp gas engine driven compressor units. Estimated cost of the construction is $1,350,000.

Cities Service to Lay Oil Gathering System

A pipe line outlet for crude oil production from the Bartholomew pool of Sedgwick and Kingman counties, Kansas, has been announced by Cities Service Pipe Line Company. The company will lay gathering lines in the field and construct necessary station tankage. The Texas-Empire Pipe Line Company will construct a trunk line from the terminus of the Cities Service gathering system to the Haven station of Service Pipe Line Company.

Construction is expected to begin as soon as pipe is delivered.



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Ohio Fuel Gas Company Proposes New Pipe Line

The Ohio Fuel Gas Company, of Columbus, Ohio, has asked the Federal Power Commission for authority to construct approximately 61.3 miles of natural gas transmission line in northern and southwestern Ohio in order to meet increased demands and future growth in the Sandusky, Elyria, and Dayton market areas.

The proposed project includes about 16.5 miles of line in Erie County, 23.1 miles in Lorain County, 8 miles in Warren and Montgomery counties, and 13.7 miles in Madison County. As a result of the construction, Ohio Fuel plans to retire and remove approximately 37.3 miles of existing line.

Estimated cost of the construction is $2,690,000, and allowing for retirement of the 37.3 miles of line, the net increase in investment would be $2,402,870, the application states.

FPC Authorizes Gas Pipe Line in Iowa

The Federal Power Commission has authorized Interstate Power Company, of Dubuque, Iowa, to construct a 26.5 mile pipe line to carry natural gas to the Clinton, Iowa, area, and has directed Natural Gas Pipe Line Company of America, of Chicago, Illinois, to supply Interstate with up to 2,733,000 cu ft of gas a day.

Interstate, which now serves manufactured gas in Clinton, will connect the new line with Natural's system near Hooppole, Illinois. The line, to be of 8⅝-in. diam pipe, will then extend from the Hooppole area, with a submarine crossing of the Rock River, to a point on the east side of the Mississippi River opposite Clinton. The gas will be carried across the Mississippi through a double submarine crossing. Estimated capital cost of the project is $749,000.

Line Would Avail Gas Company of New Sources

Mississippi River Fuel Corporation, of St. Louis, Missouri, has filed an application with the Federal Power Commission seeking authorization to construct additional natural gas facilities, including approximately 98 miles of feeder pipe line, in Louisiana and Texas to enable it to draw upon two additional sources of natural gas.

The proposed 98-mile 16 and 18-in. feeder line would extend from the California Company plant in Lincoln Parish, Louisiana, to the Woodlawn gas field in Harrison County, Texas, with an 11-mile, 10-in. lateral running southward to the Waskom field, also in Harrison County. In addition, the company would construct a gathering system in the Woodlawn field. Estimated cost of the facilities is $5,135,070, exclusive of the gathering system, which would be installed initially at an estimated cost of $489,147.

Mississippi said the proposed facilities would enable it to obtain gas from Stanolind Oil and Gas Company and Continental Oil Company out of the Woodlawn field, and from Ed E. Hurley and Byrd Oil Corporation out of the Waskom field. The application says the quantities available under the contracts are variable but will probably total at least 50,000,000 cu ft a day during the 1951-52 heating season.

Alternate Gas Connection For New York Area

The Federal Power Commission has authorized the construction by three New York companies of facilities that will provide an alternative means for the delivery of natural gas from Transcontinental Gas Pipe Line Corporation into the New York metropolitan area in the event of a break or stoppage in Transcontinental's line or in the mains of the New York companies.

The companies, Kings County Lighting Company, The Brooklyn Union Gas Company, and Consolidated Edison Company of New York, Inc., will build facilities estimated to cost $698,000, which will interconnect with the terminus of the "Narrows Crossing" extension of Transcontinental's system on the east bank of the Narrows at the entrance of New York Harbor in Bay Ridge, Brooklyn.

Transcontinental earlier this year was authorized to construct the "Narrows Crossing" to render emergency service of gas to its customers in the New York area.

Underground Storage Facilities Approved

The Federal Power Commission has authorized Texas Gas Transmission Corporation, of Owensboro, Kentucky, to construct natural gas facilities necessary to connect and operate the Alford underground storage field, near Petersburg, Indiana.

The facilities, estimated to cost $938,811, include 12 miles of connecting line, a 1200-hp gas compressor station, a storage gas measuring station, and 4.5 miles of storage field lines.

Texas Gas said that the construction will make available from storage a capacity of 30,000,000 cu ft a day. Alford field will be operated as an integral part of the Texas Gas System.

Equitable to Construct New Compressor Station

The Federal Power Commission has authorized Equitable Gas Company, of Pittsburgh, Pennsylvania, to construct and operate a new compressor station and other natural gas facilities in Washington County, Pennsylvania. Estimated cost of the construction is $1,055,739.

The project will include a new compressor station, "New Denniston Station", consisting of 3 gas engine driven 1100-hp compressor units and connecting pipe lines, a glycol dehydration plant, gas scrubbers, and auxiliary equipment.

The new compressor station will replace an existing station and will compress gas into the company's Finleyville, Tepe, and Bunola underground storage pools. Equitable estimates that with the new station, a maximum volume of 13 billion cu ft of gas can be stored in the Bunola storage pool by the fall of 1954, with a corresponding deliverability into its overall system of approximately 80,000,000 cu ft daily.

United Natural Gas Proposes Construction

United Natural Gas Company, of Oil City, Pennsylvania, has asked the Federal Power Commission for authority to construct additional natural gas transportation facilities on its system in northwestern Pennsylvania in order to increase its ability to safely supply the demands of customers.

United is proposing to construct over 10 miles of new lines in Elk, McKean, and Venango counties, to relocate and replace nearly 2 miles of pipe in Mercer and Venango counties, and to replace more than 8 miles of line in Venango and Elk counties.

In addition, the company plans to install one additional 150-hp power compressor unit at both its Hickory compressor station in Forest County and the Pinegrove compressor station in Venango County. A 100-kw 240-volt generator would be installed at its Knox station in Jefferson County.

Estimated total overall capital cost of the project is $745,500.

Northeastern Permitted To Use Larger Pipe

The Federal Power Commission has authorized Northeastern Gas Transmission Company, of Springfield, Massachusetts, to substitute 24-in. for 20-in. pipe on the 144 miles of its authorized main transmission line in Massachusetts, and to substitute larger pipe sizes on five lateral lines in that state.

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NEWS

U. S. Oil Imports Up

Imports of crude oil and petroleum products totaled 878,000 bbl per day for the week ended April 7, slightly up from the 868,900 bbl per day for the week before, the American Petroleum Institute has reported. For the four weeks ended April a total of 892,800 bbl daily was imported, compared with 903,500 bbl per day imported during the four weeks ended March 10.

The following table includes figures showing imports of crude oil and residual fuel oil since the 4 weeks ended April 7.

(Figures in barrels per day)

Four Weeks Ended	Crude Oil	Residual Fuel Oil	Other Products	Total
April 7	523,200	339,500	30,100	892,800
Weeks Ended				
April 7	502,800	347,900	27,300	878,000
March 31	538,800	300,300	29,800	868,900
March 24	491,500	425,500	26,800	943,800
March 17	559,800	284,200	36,400	880,400

Annual Reports Show 1950 Income At New High

The U. S. oil industry enjoyed its second record year in 1950, with most companies reporting higher incomes than those of 1949. The other record year was 1948.

Tide Water Associated Oil Company reported the second highest income in the history of the company, with a 1950 income of $33,364,000. Socony-Vacuum reported $128,200,000 net income, Standard Oil of California's net earnings reached $150,804,105, compared with $136,017,835 for 1949. Sunray Oil net profit (including Barnsdall Oil since June 23, 1950) amounted to $20,462,000. Mid-Continent Petroleum Corporation net income totaled $15,662,632 compared with $12,080,616.

Prestage Named To Head Theft Prevention Program

Fred H. Prestage, Wichita Falls, district supervisor for the Texas Liquor Control Board, has been named special investigator for the Texas Mid-Continent Oil and Gas Association's theft prevention program. A former Grayson County sheriff and wartime military police investigator, Prestage will assist Chief Investigator George W. Robey of Coleman in the Association's joint effort with police authorities to stop theft of oil field equipment.

"High prices resulting from the scarcity of pipe and other valuable oil field equipment, have brought more thieves back into the oil fields," Charles E. Simons, Association general manager, told members in a letter on Prestage's appointment.

Prince Bernhard Patron of World Petroleum Congress

The organizing committee of the Third World Petroleum Congress reports that H. R. H. Prince Bernhard of the Netherlands has agreed to become the Patron of the Third World Petroleum Congress, to be held in The Hague/Scheveningen from May 28 to June 6, 1951.

In addition to the president of the Congress, Jonkheer O. C. A. van Lidth de Jeude, the following will act as vice presidents of the Congress: P. Erculisse (Belgium), R. Navarre (France), C. A. P. Southwell (Great Britain), M. Boldrini (Italy), Frank M. Porter (United States), and Dr. Gustavo Théry-Fombona (Venezuela).

All these men are the chairmen of national associations of petroleum technologists in their respective countries. Although originally 1200 people were expected to take part in the Congress, more than 1300 have so far actually signified their intention to attend. In addition, about 300 ladies will be present. It is to be expected that this number will rise still further.

Besides Frank Porter the following American petroleum leaders have been named on the Committee of Honour:

W. Alton Jones, president of Cities Service Company and chairman of the board of the API; Lt. Gen. E. O. Thompson, member of the Texas Railroad Commission; and Dr. W. E. Wrather, Director of the U. S. Geological Survey.

Dr. E. V. Murphree of the Standard Oil Development Company is chairman of the National Committee for the United States of America, the vice chairmen being F. S. Clulow, Shell Oil Company and Dr. Paul D. Foote, Gulf Research and Development Company. H. R. Tate of Standard Oil Development, and Mrs. Luther D. Swanstrom of Master Reporting Company are assistant secretaries.

FPC Limits Hearing In Phillips Suit

The Federal Power Commission has limited the Phillips Petroleum Company hearing to the issue of whether the firm is a natural gas company and therefore subject to FPC regulation. The hearing, being held at Bartlesville, Oklahoma, was originally set to determine whether Phillips was subject to the Natural Gas Act, and also whether the firm's rates, charges, or classifications are "unjust, unreasonable, unduly discriminatory, or preferential." The FPC announced that a hearing on other phases of the proceeding will be held at a date to be decided later.

Oil Demand, Output Forecast To Reach New Records

New all-time records for demand and production will be established by the petroleum industry in 1951, Walter S. Hallanan, president of Plymouth Oil Company, and head of the National Petroleum Council, has predicted. Whether the industry will be able to keep pace with the ever-growing demand for its products by drilling an increasing number of wells and continually raising reserves to new high levels will depend, he said, upon continuance of the present 27½ per cent rate of depletion and ability to obtain steel and other materials.

He added that in response to the demands of the mobilization program, the industry established new records in every division of its multiple activities in 1950. He pointed out that the industry had drilled more wells, increased reserves to an all-time high of more than 29,000,000,000 bbl, refined more oil and produced more motor fuel, natural gas, and natural gas liquids than ever before, as it met a demand that reached a record high for the eighth consecutive year.

Houston Meeting Called on Industry Radio Frequencies

A meeting of the National Petroleum Radio Frequencies Coordinating Association, Region 4, will be held May 25-26, at the Lamar Hotel, Houston, Texas, according to G. F. McReynolds, Humble Oil and Refining Company, chairman for the region. Election of officers will be held and the members will vote upon a motion to be submitted to the Federal Communications Commission that the petroleum radio frequencies should be shared with the National Forest Industries communications. This is an important decision that needs the votes of all the 6000 members, McReynolds states. There is a national meeting to be held in Washington, D. C., June 7, at which time the 12,000 members in the Association are urged to attend.

Iraq Royalties Increased

The Iraq Petroleum Company, partly owned by American interests, is reported to have agreed to increase Iraq royalties to rates about equal to those paid nearby Arab nations by foreign interests. This could be as much as 50 per cent of profits. The Iraq Premier who made the announcement, stated all oil companies had agreed in principle to an increase. He added that this increase would remove the need for nationalization, but stipulated the royalties be paid in gold on a free-market basis.

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World Oil Output Rises In October B of M Reports

World production of crude petroleum in October averaged 11,180,000 bbl daily, a gain of 150,000 bbl daily over the September production rate. Practically all the major producing countries except Indonesia showed gains over September. The largest increase in daily average production over September were: Saudi Arabia 48,000 bbl, Venezuela 26,000, Kuwait 19,000, United States 12,000, Iran 11,000, and the U.S.S.R. 25,000 bbl estimated. New monthly production records were established in Colombia, Venezuela, Germany, Saudi Arabia, Kuwait, and Iraq in October.

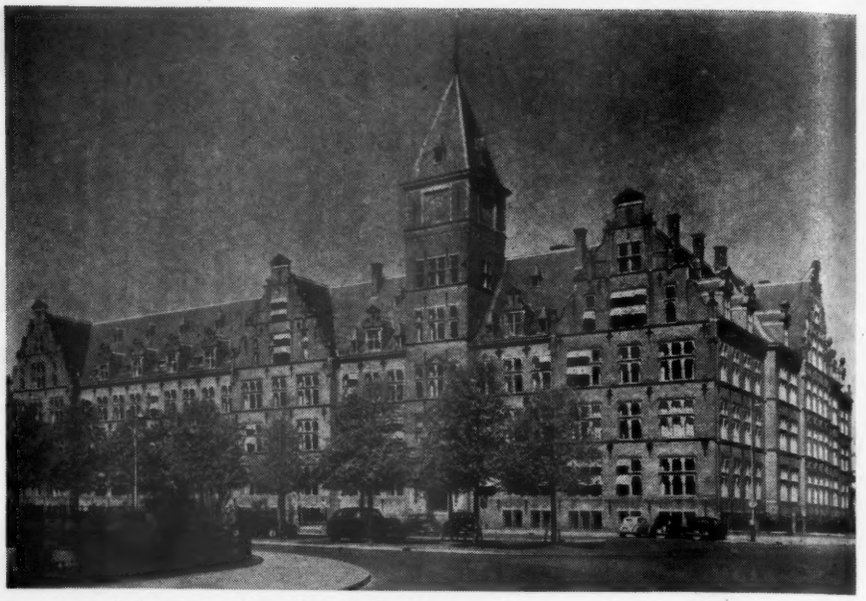
Crude oil imports by western European nations increased 34,000 bbl daily over September to 885,000. The principal importers were, in barrels daily: France 368,000 (September 329,000), United Kingdom 206,000 (169,000), Italy and Trieste 121,000 (107,000), the Netherlands 105,000 (136,000), and western Germany 51,000 (59,000). Crude oil exports from Venezuela totaled a record 40,200,000 bbl in October, and Colombia crude exports also made a monthly record. Middle East exports of crude to outside areas averaged 933,000 bbl daily compared with 961,000 in September.

Texas Allowable Set At Record-High Rate

Texas crude oil producers have been granted a record-high production rate this month. The daily production allowable for May has been set at 2,936,323 bbl of crude oil, up 10,741 bbl from the April 14 allowable of 2,825,582 bbl, the former high record. The Texas Railroad Commission ordered a production schedule in May of 24 days for Texas fields generally, and 19 days for East Texas.

Canada Expected To Get U. S. Steel Allocation

Prospects that Canada will get as much steel as if it were a part of the U. S., became a near certainty with the announcement by Dr. O. B. Hopkins that the U. S. steel allocation system will be extended to Canadian operators. Director of the petroleum division of the Department of Trade and Commerce, Hopkins announced that beginning with the third quarter, of 1951, U. S. oil country tubular goods will be allocated under the direction of the Petroleum Administration for Defense in Washington. It is expected, Hopkins stated, that the allocation system will be extended to Canadian operators and will be administrated in Canada by the petroleum division.



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OPS Puts Ceiling Prices On Most Petroleum Products

Ceiling Price Regulation 17 has been amended to include limit on prices of natural gas, petroleum gas, casinghead gas, and refinery gas. Prices were frozen effective April 10 on petroleum products at the highest price charged during the period December 15 to January 25. Office of the Price Stabilization announced that this is the same base price used in the general ceiling price regulation, and in general the price levels are equal to, or lower than price levels in 1948 and early 1949. Michael V. DiSalle, director of OPS said few, if any, price increases will result from the regulation.

Exempt from the order are ceiling schedule sales of aviation gasoline of 100 octane or higher when made to a defense agency or to any person for use in connection with defense contracts or subcontracts.

Known as CPR-17, the new regulations covers products at all levels of distribution, except service stations and other retail establishments, the products specifically being:

Liquefied petroleum gases, natural gasoline, aviation gasoline, automotive and marine gasoline, all petroleum, naphthas and solvents; stove and lamp gasoline and pressure appliance fuels; jet propulsion fuel; tractor fuel, kerosene, range, stove and heater oils; Diesel fuels, gas oils, gas enrichment oil, residual fuel oils, and "all other distillate burning, heating and fuel oils."

Under pricing methods for natural gas, casinghead gas, and refinery gas, a provision has been included in the amendment to permit long term contracts to continue in effect. Such contracts are customary in the industry, many having been written several years prior to the base period to continue in effect for as long as twenty years. Moreover, many phases of the industry are subject to permanent Federal and State regulatory agencies.

Permission for this type of contract to continue in effect in accordance with contract terms will not increase the general level of prices for gas beyond prices under long term contracts, nor to create hardships for purchasers. Most of the gas which will be sold under the pricing provisions of this regulation is delivered through long pipe lines certificated by Federal and State regulatory authority.

The practice in the gas pipe line industry is to amortize the investment over a period of years and such amortization is in part related to the terms of purchase contracts covering the gas supply to such lines.

Royal Dutch History Translated To English

"The Royal Dutch Petroleum Company — 1890-1950" has now been translated to English. The book was published last year, commerating the Royal Dutch Company's 60th year of organization, and it contains the highlights of the past 60 years. It is very well written, and the illustrations are both interesting and educational. It is divided into 9 chapters including one on exploration, production, processing, chemical industry, transport, scientific research, marketing, and personnel, and glimpses of the past 60 years. The alliance with Shell and expansion of oil interests into the four corners of the earth is a great modern story.

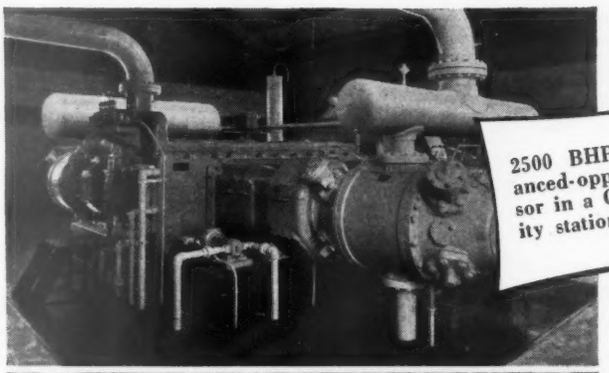
Original installation on piling over Lake Maracaibo, Venezuela.

18 YEARS AGO...the first TODAY...still the first!

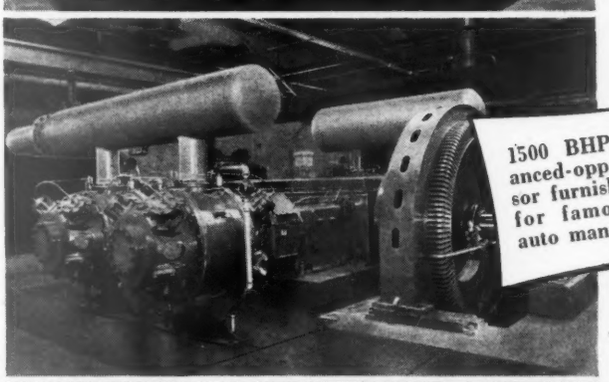
A Venezuelan oil producer ordered it, in 1932. The original heavy duty, balanced-opposed, motor-driven compressor. *A noteworthy Clark first!* And like 15 similar units added subsequently, it has delivered continuous, vibration-free service over the years.

In 1946 came a second major Clark development . . . a new line embodying components of the famous angle type compressor. Two, four and six-cylinder models in 8″, 14″ and 17″ stroke sizes broadened the range to cover 150 to 4500 BHP.

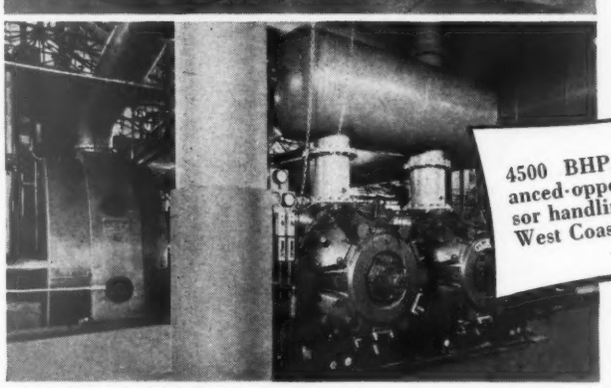
Today, Clark remains the pioneer, with continuing improvements in design and performance. *Data and illustrated catalog from your nearest Clark representative.*



2500 BHP, 4 cyl. balanced-opposed compressor in a California utility station.



1500 BHP, 4 cyl. balanced-opposed compressor furnishing plant air for famous Michigan auto manufacturer.



4500 BHP, 6 cyl. balanced-opposed compressor handling mfd. gas in West Coast utility plant.

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Follis Optimistic About U. S. Oil Interests Abroad

Back from a five-weeks' air trip around the world, Board Chairman R. G. Follis of Standard Oil Company of California says he feels very much reassured by the state of his company's oil investments abroad—"more so than any time since the end of the war."

He based his opinion on numerous talks with public authorities and business men in the dozen countries he visited. Among the countries in which he stopped were Portugal, Syria, Lebanon, Trans-Jordan, Saudi Arabia, Bahrein Island, Pakistan, India, Thailand, Malaya, Indonesia, and Australia.

"Oil concessions held by American companies are in friendly states," he said.

One impression he received was that the Russian and Chinese communists' position has deteriorated.

"The feeling I ran into," he said, "is that the democratic forces are now on the march."

He found this particularly true in Southeast Asia, because of two things: The developments in Korea and the action of the French in granting independence to Indo China. This jerked out the props of communist propaganda regarding colonialism.

"The governments in this area are on our side, not necessarily because they like it, but for their own purposes. They have needed help to combat the propaganda that the Russians and Chinese were going to win anyway, so people might as well get on the winning side."

Follis spoke particularly of the problems created by the tremendous influx of refugees, mostly Arab, particularly into the countries of Syria, Lebanon, and Trans-Jordan. He said various estimates placed their number between 800,000 and 1,500,000 persons.

"The Communists are not neglecting the chance to talk to them," he said. "It has the rulers of these countries worried." He added that the United Nations had a job to do in improving their condition and providing them with jobs, food, and clothing.

Follis said relations between Arabian American Oil Company, in which his company holds a 30 per cent interest, and King Ibn Saud of Saudi Arabia were excellent. He visited the King and Crown Prince.

"I found an atmosphere of good will toward the Americans. The renegotiation of the concession has brought about a great deal of satisfaction. I do not think that what has happened in Iran is around the corner in Saudi Arabia. In effect, the Saudi Arabian government is now equal partners with Aramco, without putting up the capital."

He said that in addition to the increased income to Saudi Arabia from renegotiation of the concession, Aramco was proceeding with its program to improve the Arab's health and to educate them to move up in the organization.

In Indonesia, Follis said an affiliated company was just getting started, but that properties there were regarded as important — "There's no question but that there is a terrific amount of oil in this area. That's why we're encouraged to go forward there."

He reported Australia was very anxious to develop a domestic oil industry and that some possible oil producing area has been "Looked at."

"We'd like to find oil there, but we haven't any place where we'd like to drill. We've looked at some possible properties, but we do not know what we'll do. The areas examined by our people in the south and west areas of Australia are very isolated."

Gas Committee Named

A 61-man gas industry advisory council has been appointed by Secretary of the Interior Oscar L. Chapman. He stated that the council will advise him on matters connected with defense responsibilities regarding gas, and that he will call its first meeting at an early date.

Sinclair Forms New Research Subsidiary

Formation of Sinclair Research Laboratories, Inc. and election of directors and officers of the new, wholly-owned subsidiary of Sinclair Oil Corportation, has been announced. The new company will take over all the research activities of the Sinclair companies, including the extensive laboratories at Harvey, Illinois.

The new corporation was created to expand the use of Sinclair's research facilities and skilled personnel in the interest of further technological advancement.

Elected as officers of Sinclair Research Laboratories, Inc., were: E. W. Isom, chairman of the board; P. C. Spencer, president; W. M. Flowers, executive vice president, and E. C. Herthel, vice president. Named as directors were: W. R. Argyle, W. M. Flowers, E. C. Herthel, E. L. Hughes, E. W. Isom, T. B. Kimball, W. H. Morris, H. L. Phillips, and P. C. Spencer.

Aluminum Production Up

"Average daily production of primary aluminum in the United States during February advanced more than two per cent over the January rate," reported Donald M. White, secretary of The Aluminum Association, "reflecting the industry's continuing efforts to boost its output." Because February is a shorter month, however, the total amount produced was less.

1951 officers of the Delta chapter of American Institute of Mining and Metallurgical Engineers were named at a New Orleans meeting. They are: Seated: Raymond B. Kelly, Jr., Richardson Bass, vice chairman; H. M. Krause, Jr., Humble, chairman; J. E. R. Sheeler, Shell, vice chairman; standing, J. H. Homer, Humble, secretary; J. H. Rambin, Jr., The Texas Company, director; A. L. Vitter, California Company, treasurer; E. N. Van Duzee, Shell, director.

French Students Study Engineering in U. S. A.

Eleven of France's leading petroleum engineers are at the University of Texas for a nine-month study of the U. S. petroleum industry. Dr. W. A. Cunningham, university chemical engineering professor, is directing their work, which includes in-service training in the petroleum industry and attending advanced classes and seminars at outstanding universities throughout the nation.

The special program is sponsored jointly by the Economic Cooperation Administration and the French government.

"France and her territories contain five per cent of the world's areas where oil will most likely be found," Dr. Cunningham explained. "However, oil development in those areas is just getting under way.

Women Engineers Meet

The need for women engineers in our expanding technology and particularly, in the present emergency, was the central theme of the third annual conference of the Society of Women Engineers held in New York.

Miss Beatrice Hicks, president of the society, (in her opening talk) pointed out that the present desperate shortage of people trained in engineering will continue to grow, and the needed personnel will be drawn from those having engineering background whether men or women.

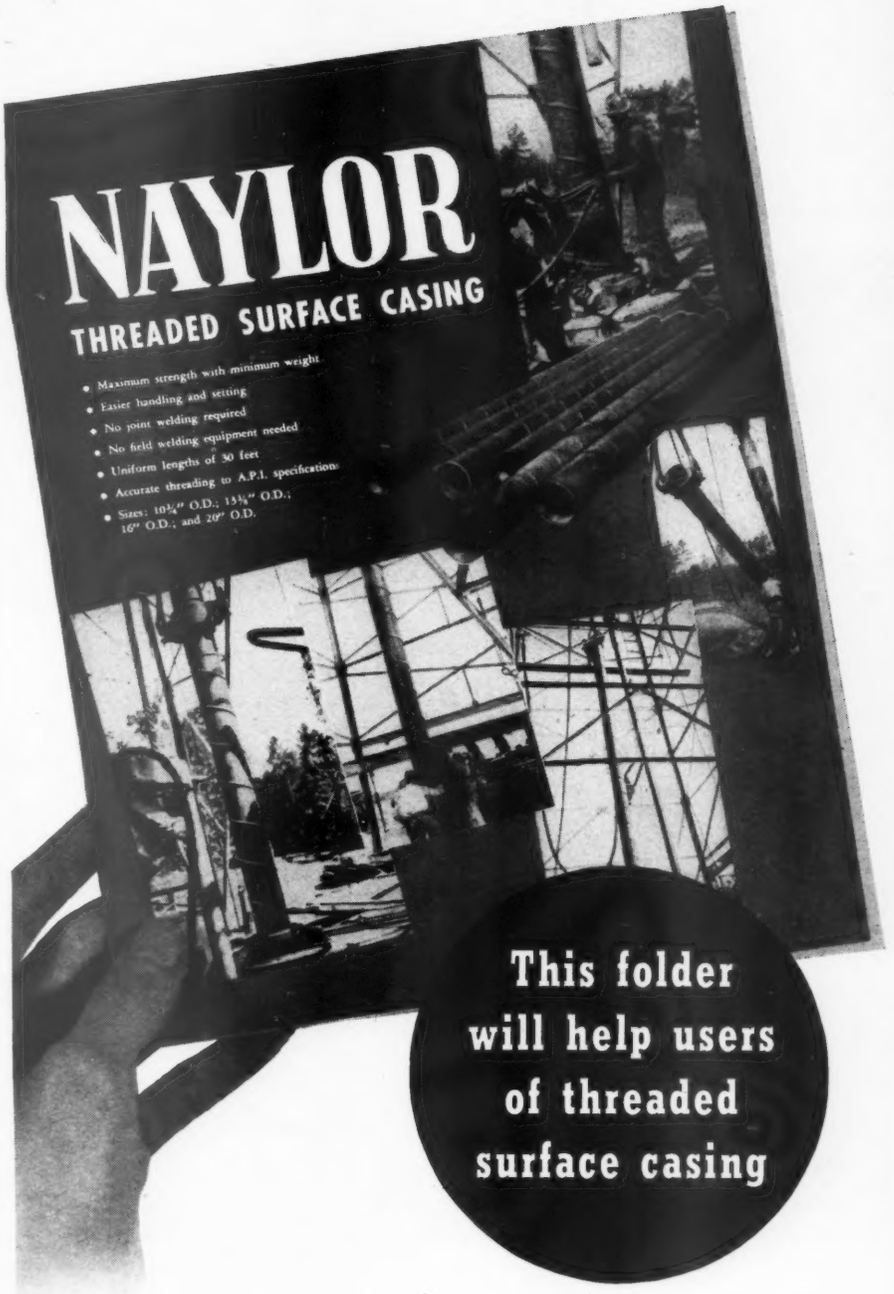
WANTED—PIPE LINE ENGINEER-ECONOMIST

Large integrated oil company wishes to engage in staff capacity an experienced pipe line engineer who has ability and experience in economic analysis of crude oil and products, pipe line facilities—both existing and proposed. Company does not have man specializing in this field. Location would be in home office in Eastern United States. Please state age, experience, and give references with first reply. Box 124, % The Petroleum Engineer, P. O. Box 1589, Dallas, Texas.

HELP WANTED

ELECTRICAL ENGINEER WITH CRUDE OIL PIPE LINE EXPERIENCE. FAMILIAR WITH DESIGN OF ELECTRIC PUMP STATIONS, AUXILIARY ELECTRIC MACHINERY AND EQUIPMENT, REMOTE CONTROL CIRCUITS, POWER SUB-STATION AND DISTRIBUTION CIRCUITS FOR INSTALLATIONS UP TO 5000 HORSEPOWER. FAMILIARITY WITH COMMUNICATION CIRCUITS AND ELECTRONIC EQUIPMENT ALSO REQUIRED. INCLUDE FULL PROFESSIONAL AND PERSONAL DETAILS FIRST LETTER.

Write Box 123, c/o The Petroleum Engineer, P. O. Box 1589, Dallas, Texas.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THREADED SURFACE CASING
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This folder will help users of threaded surface casing

To show how Naylor Threaded Surface Casing can fit into your operations, Naylor has prepared this handy bulletin. It presents helpful information and complete specifications in concise form. You can obtain your copy without obligation by writing our distributor or sending your request to us.

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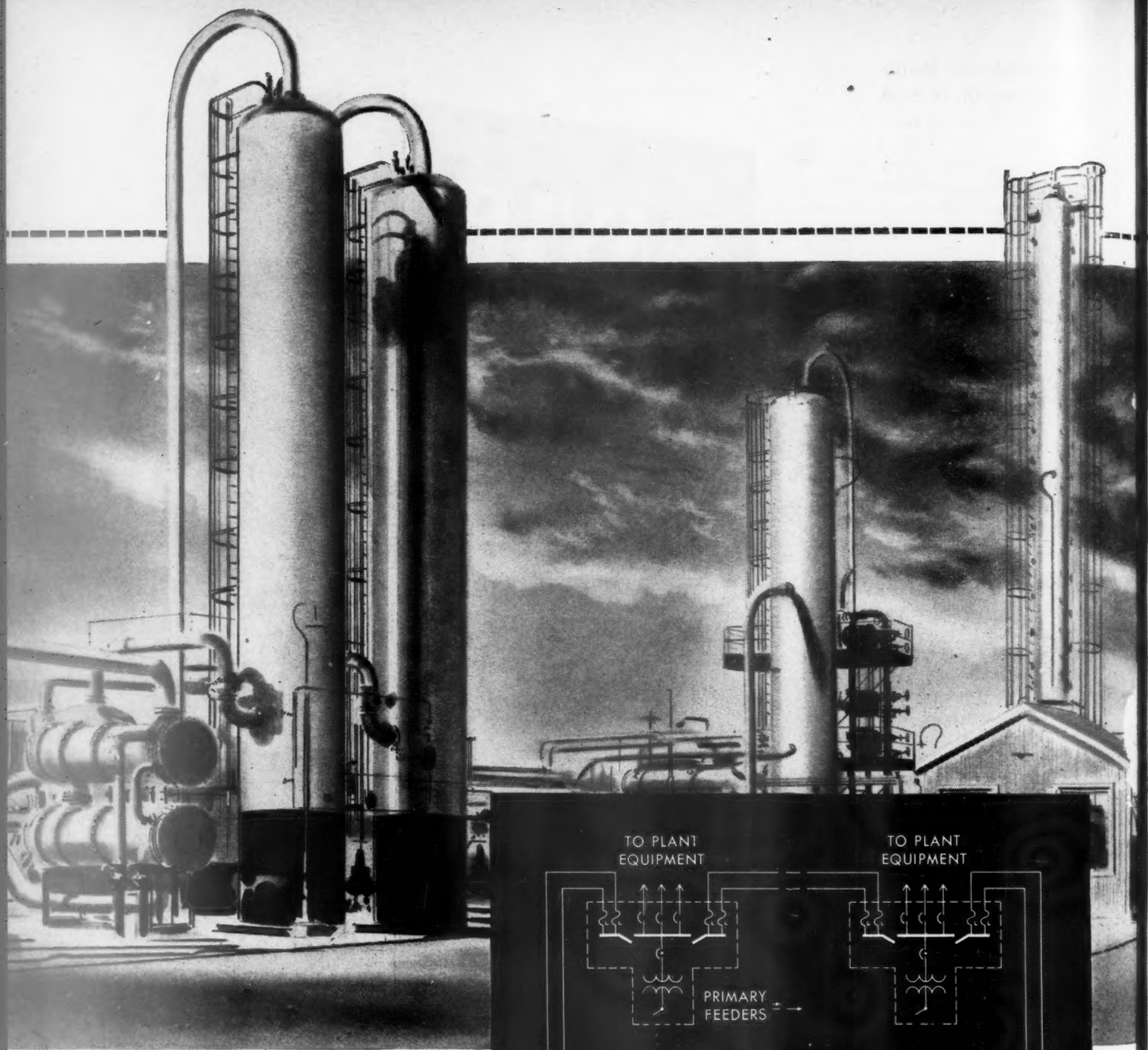
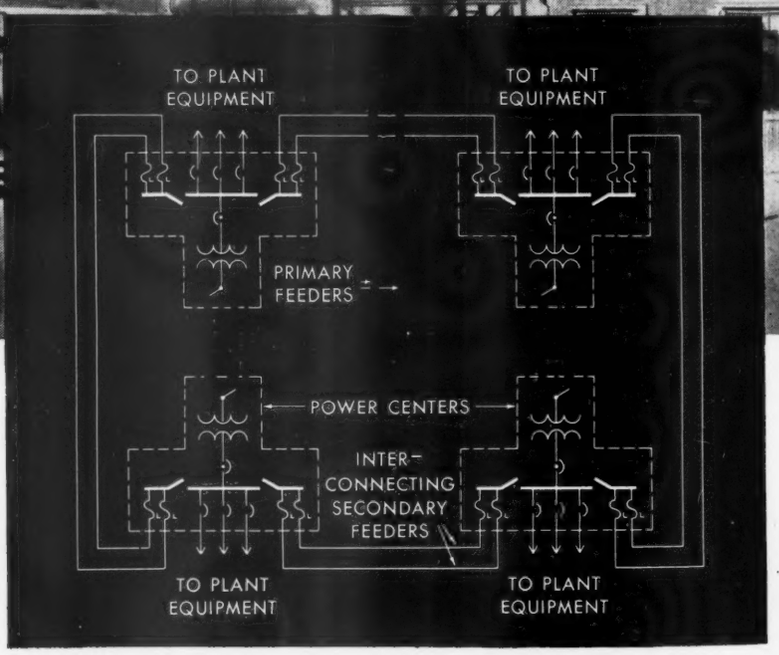
Exclusive distributors in Mid-Continent and Gulf Coast Areas





PRIMARY SELECTIVE NETWORK SYSTEM

This system rates high on service continuity and flexibility. Two Primary Feeders supply power. If a fault occurs on one, the other Feeder takes over to keep service continuous. If a fault occurs in a Power Center, its section of the plant is supplied by the adjacent Power Centers through the interconnecting Secondary Feeders.

When additional power is needed, one Primary Feeder supplies the plant while a new Power Center is connected to the dead feeder. The plant keeps operating.

This is one of eleven basic systems, all with varying characteristics. Let experienced Westinghouse engineers help you plan the system best fitted to *your* operations.

EQUIPMENT FOR THE PETROLEUM INDUSTRY

YOU CAN BE **SURE**.. IF IT'S
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HOW MUCH DOES IT COST

when a distilling column goes "down"?

Probably more than you care to think about. But when power failure is at fault this costly threat can be eliminated. The answer:

A planned power distribution system!

When you modernize existing plants or build new ones, plan a system that *insures* service continuity . . . that gives you *alternate* power routes when electrical troubles occur. Moreover, make sure the system will be flexible . . . to permit load shifts and allow expansion without shutdown.

The Primary Selective Network shown on the opposite page is an example of a system that gives you this important service continuity and flexibility. But this is just one of the many systems you'll want to consider. Each has specific advantages depending on your particular operation. And Westinghouse can help you and your plant contractor design the system that *best* fits your requirements.

To help you make preliminary decisions we've prepared informative material covering all systems. Write for yours now. And remember, when you're building or modernizing, call in your Westinghouse engineers. With wide experience in power problems they can help you plan the one best system for your particular operation. J-94855

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"Industrial Plant Distribution Systems": 34 fact-filled pages completely explain the eleven basic systems. Ask for B-4045.

A System Selector: pocket-sized selector card quickly shows the characteristics of each type.

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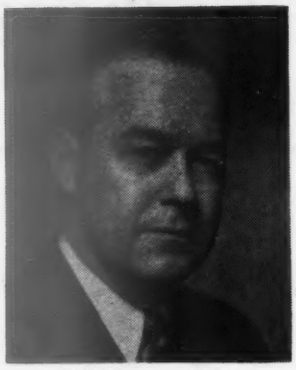
Personals



William P. Gee

William P. Gee, vice president of Texaco Development Corporation, has been promoted to assistant to the president of The Texas Company. Gee attended the University of Texas and Massachusetts Institute of Technology. He entered the oil business in 1919, and was first employed by The Texas Company in 1927 as a research chemist in the Port Arthur, Texas, refinery. He has been actively engaged in the development and commercialization of many of the processes licensed by The Texas Company. Previously he has been engaged in the process licensing phases of the business of Texaco Development Corporation.

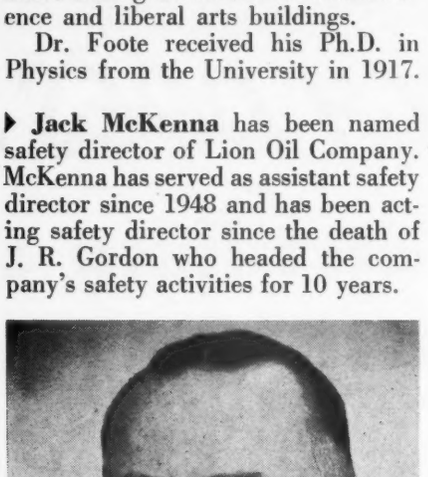
L. L. Dresser, prominent oil engineer and civic leader of Tulsa, Oklahoma, has been named president of the National Society of Professional Engineers. At present vice president of the Southwestern Area, NSPE, and former holder of many state and national society offices, he is president of the Dresser Engineering Company, Tulsa, Oklahoma. He is serving on various committees of the Tulsa Chamber of Commerce and is a member of the Tulsa County Master Plan Committee. In addition, he is a member of the Technical Club, Governor Turner's Citizens' Advisory Committee, and president of the Natural Gasoline Supply Men's Association.

Morton F. Leopold, who has been in charge of motion picture production for the Bureau of Mines for more than three decades, has been presented a gold medal and a citation for distinguished service. Presentation of the Distinguished Service Award of the United States Department of the Interior was made by James Boyd, director of the Bureau of Mines and Defense Minerals Administrator, on behalf of Secretary of the Interior Oscar L. Chapman. Leopold, who joined the Bureau a few months after its creation in 1910, was placed in charge of the Bureau's motion picture and lantern slide work in 1918.

Dr. Paul D. Foote, vice president of Gulf Oil Corporation in charge of research and development, was presented with the Outstanding Achievement Medal Award of the University of Minnesota at Minneapolis. The honor is reserved for former students who have attained high eminence and distinction. It was conferred as part of the University's centennial observances during dedication of social science and liberal arts buildings.

Dr. Foote received his Ph.D. in Physics from the University in 1917.

Jack McKenna has been named safety director of Lion Oil Company. McKenna has served as assistant safety director since 1948 and has been acting safety director since the death of J. R. Gordon who headed the company's safety activities for 10 years.



W. T. Nightingale, new president of Mountain Fuel Supply Company, Rock Springs, Wyoming. In the item making the announcement last month, the photo of another man was used.

Rayburn L. Foster, new Phillips Petroleum Company director. The wrong photo was identified as Foster last month.

John W. Brice

John W. Brice, The Carter Oil Company, has been elected to the new position of chairman of the board of directors effective June 8, following the completion of his present term as a member of the board of directors of Standard Oil Company (New Jersey). O. C. Schorp, who continues as chief executive officer of the company, stated that the new Carter office of chairman of the board was established to aid in the formulation of long range plans and broad corporate policies.

Brice, a former Carter executive vice president and director, was graduated from the University of Texas in 1927. He first joined Carter in 1942 as a director and vice president in charge of exploration, becoming executive vice president in 1943. In 1945, he was transferred to the Jersey company in New York as assistant coordinator of producing, later becoming coordinator. In 1949, he was elected a member of the Jersey Board.

Dr. Frank C. Fowler, formerly of the University of Oklahoma faculty, has been added to the staff of Midwest Research Institute, Kansas City, as petroleum consultant. Fowler attended the universities of Illinois and Michigan, and was awarded the Ph.D. degree from the latter school in 1943.

He will conduct investigations in petroleum and allied fields for the Institute.

Dr. Norman Hackerman, University of Texas Corrosion Research Laboratory director and chemistry professor, will lecture June 18-23 at the Massachusetts Institute of Technology.

Charles E. Simons, vice president and general manager of the Texas Mid-Continent Oil and Gas Association, has been appointed to the American Petroleum Institute's Committee on Highways. Simons has been long associated with highway improvement work, having formerly served as executive officer for the Texas Good Roads Association for 11 years prior to taking the Mid-Continent post.

▸ **Dr. Karl V. Kitzmiller** has been named associate medical director of Ethyl Corporation. He will direct the medical work of the corporation and act in a supervisory and advisory capacity on medical problems of the sales, research, and manufacturing departments, relieving Dr. Robert A. Kehoe, medical director, of all duties possible in Ethyl's health and safety operations. Dr. Kitzmiller joined Ethyl's medical department in 1926, was named medical supervisor in 1942 and assistant medical director in 1946.

▸ **George C. Merrick** has been named industrial relations supervisor for Stanolind Oil and Gas Company's Texas-Louisiana Gulf Coast division. Merrick comes to Houston from Brownsville, Texas, where he was industrial relations supervisor for Stanolind's new chemical plant. Although he is a native of Illinois, Merrick has spent a reat deal of time in Texas since his graduation from Yale University in 1940. He joined Stanolind that year and worked in the company's Hastings field south of Houston before taking a military leave of absence in 1941.

▸ **Andrew Kalitinsky,** former chief engineer of the NEPA (Nuclear Energy for Propulsion of Aircraft) Project, has been appointed by The M. W. Kellogg Company, refinery and chemical engineers of New York City, as manager of the company's special projects department. This department is playing an increasingly important part in research and development of rockets and rocket motors for the U. S. Air Force and Navy.

One of the youngest men ever to receive the honor, Kalitinsky was awarded the Manly Memorial Medal in 1949 by the Society of Automotive Engineers for his paper, "Atomic Power and Aircraft Propulsion." The medal was established in honor of the late Charles Matthews Manly, a pioneer in the aircraft engine field, and its awards constitute a capsule history of the progress in aircraft propulsion. He was educated at the Swiss Federal Institute in Zurich.

▸ **G. Gordon Biggar,** assistant manager of public relations for Shell Oil Company, New York, was elected president of the Industrial Audio-Visual Association at its annual meeting recently held in Chicago, Illinois.

Other officers elected included **Daniel Rockford,** Standard Oil Company (New Jersey), vice president; **Frank Howe,** Pan-American Airways, New York, eastern district director; **William Pratt,** American Telephone and Telegraph Company, New York, corresponding secretary; **Donald Steinke,** Dow Chemical Company, Midland, Michigan, recording secretary, and **J. T. Hawkinson,** Illinois Central Railroad, Chicago, treasurer. Biggar is a charter member of the association and has served both as eastern district director and vice president. He joined Shell is 1926.

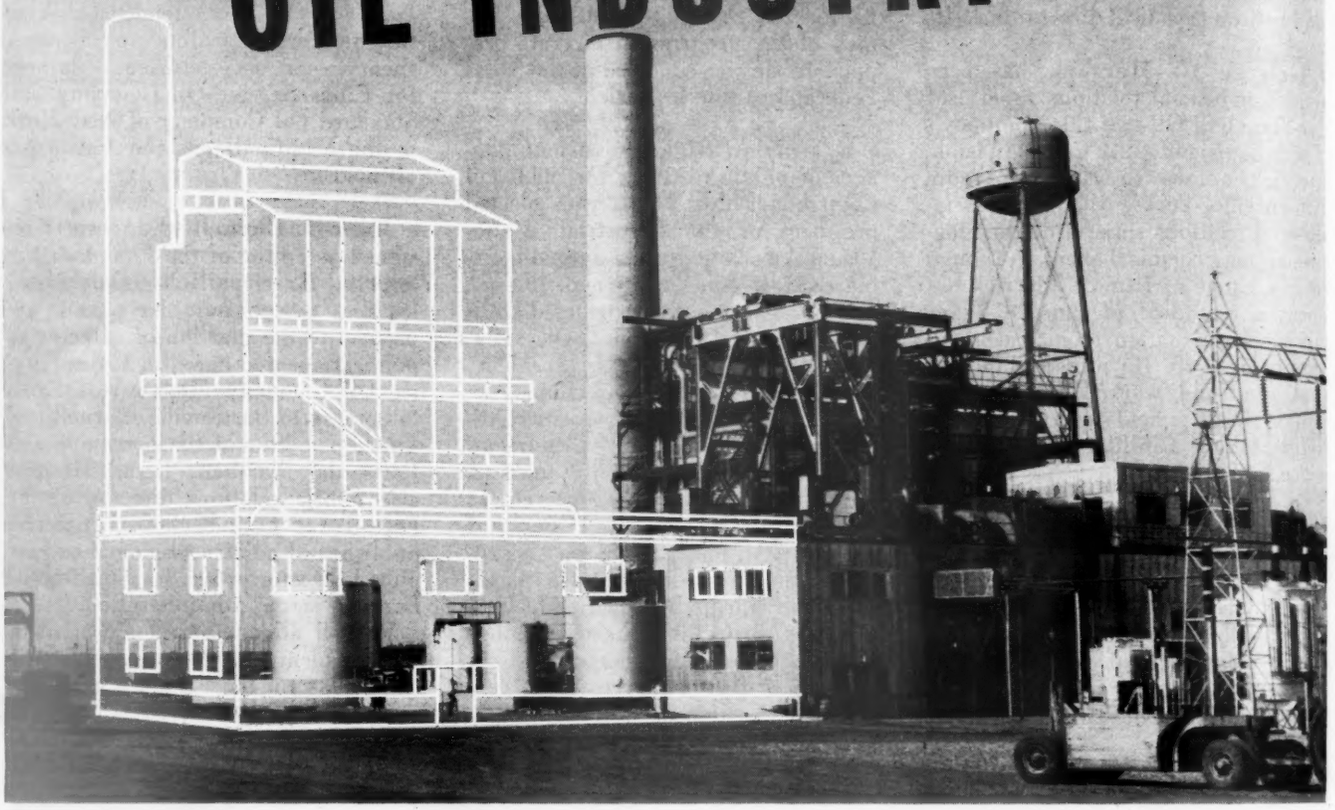
▸ **Alec M. Crowell** has taken a leave from Natural Gas Associated Consultants, New Orleans, to be chief of Fuel and Chemical Section, New Orleans district, Office of Price Stabilization. He will work under the supervision of **L. J. Dumestre,** director, and **Gerald E. Warren,** price executive, in the organization of the OPS program regarding natural gas, crude oil, gasoline, heating oils, kerosine, liquefied petroleum gas, lube oils and greases, as well as sulfur and chemicals. Crowell, who attended Universities of North Carolina and Kansas, spent 8 years as a petroleum engineer for Cities Service Oil Company and Standard Oil Company of New York in the Mid-Continent and California oil fields.

▸ **John H. Purnell** who recently resigned as editor of the Examiner-Enterprise, Bartlesville's (Oklahoma) leading newspaper, has been appointed to the position of director of publications and news for Cities Service Oil Company (Delaware). Prior to coming to Bartlesville, Purnell had served as editor of the newspapers at Paris and Marshall, Texas. He was also public relations director of the East Texas Chamber of Commerce, publisher of a dairy magazine and regional director of information for the Farmers Home Administration.

Purnell attended Gulf Coast Military Academy, Louisiana Polytechnic Institute, Centenary College and Louisiana State University.

The 1950 officers of the Los Angeles Nomads are shown here after turning over their duties to the new officers. They are Hearn J. Paschall, J. A. Engstrand, K. F. Forsyth, James D. Hughes, Earl M. Boggess, John H. Flanagan, J. C. Ballagh, John W. Rife, and Lee J. Laird. The photo was taken at the annual Nomads banquet.

*MORE POWER FOR THE OIL INDUSTRY



Since 1945, we've more than tripled our power generating capacity — from 121,000 to 374,275 kilowatts at the end of 1950. New plants totaling 124,000 kilowatts are scheduled for 1952. New transmission lines, substations and distribution systems round out the most ambitious building program in the company's history.

The power system of Texas Electric Service Company has for many years supplied electric power for well pumping, pipe line pumping, refining and well drilling in many West Texas oil fields. Electric power, through these many years, has been one of the greatest single aids in the development of West Texas' oil potentials.

*Shown above is the 44,000 kilowatt Morgan Creek steam-electric generating station of Texas Electric Service Company near Colorado City and in the heart of the most active oil producing and oil transportation development in the mid-continent area. The white outline shows the location of the second 44,000 kilowatt unit, now under construction and scheduled for completion next year.

TEXAS ELECTRIC SERVICE COMPANY

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LAUGH with BARNEY

Overheard in the cold war: The Soviet government points with great pride to the fact that Russian women do a man's work and get a man's pay.

That's nothing. Over here women can get a man's pay without doing any work at all.

In any responsible situation, to do less than your best is degrading.

Most women would be more spic if they had less span.

The family was engaged in the game of questions and answers, when Mother directed a question to little Marjorie.

"Dear," Mother inquired, "what is the opposite of permanent?"

The child reflected a moment, and then replied, "Oh, yes, straight hair!"

An army private was hauled on the carpet for returning late with a load of supplies. "Well, sir," he said, "I picked up a chaplain along the road, and after that, those mules couldn't understand a word I said."

Many a man has been stung trying to get himself a little honey.

A young father was telling a group of friends what a bad time he had when his baby was born. Finally a young matron inquired, "Who had that baby, anyway?"

The young man nodded toward his wife. "She did," he answered, "but she had an anesthetic." — *Capper's Weekly.*

Department of Revenue Note: In many of our dealings with Uncle Sam he requires us to prove that we were born by submitting a birth certificate —but when it comes to collecting taxes from us, he never doubts our existence.

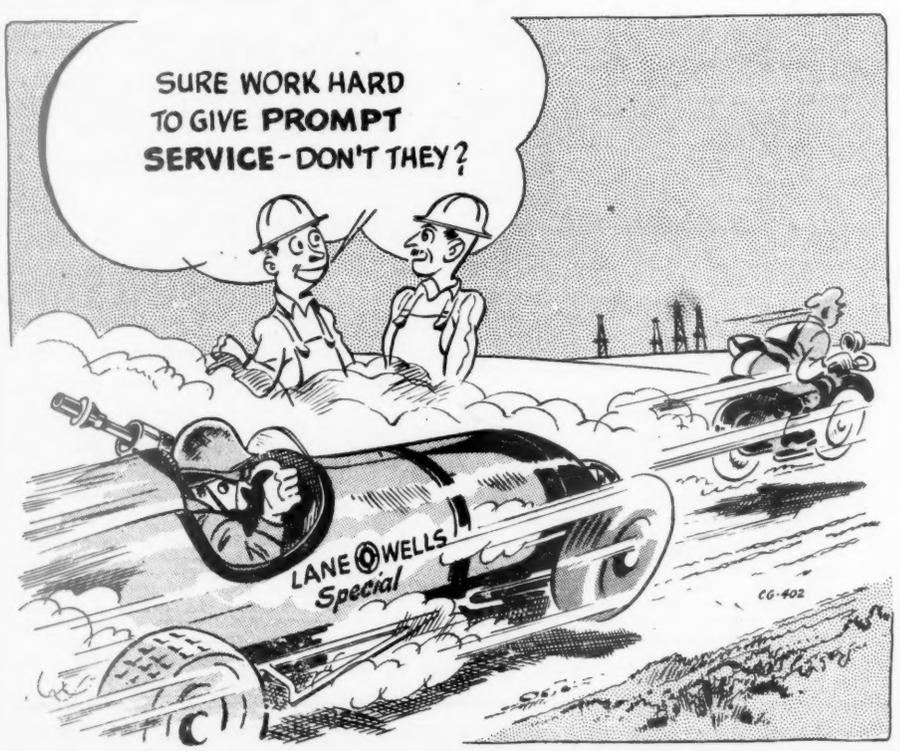
Mrs. Jones was spending a day in bed with a severe cough, and her husband was working in the back yard, hammering some nails into a board. A neighbor came over to watch him as he worked.

"How's the wife?" the neighbor asked.

"Not very well," replied Jones.

"Is that her coughin'?"

"No," replied Jones, "it's a chicken house."



A farmer visiting a state mental hospital was strolling about the grounds when he came upon an inmate sprawled restfully under the shade of a tree. After a word of greeting the man sat up and eyed his visitor with interest.

"What do you do for a living?" he finally asked.

"I'm a farmer."

"Farmer, huh? I used to be a farmer. Darned hard work."

"Sure is," agreed the visitor.

"Ever try being crazy?"

"Why no," the shocked farmer replied.

"You ought to try it some time," declared the inmate as he again relaxed on the cool grass. "Beats farmin.'"

Papa Robin: How did that speckled egg get in our nest?

Mama Robin: I did it for a lark.

Dick: I think we ought to teach that dizzy redhead the difference between right and wrong.

Joe: Good idea. You teach her what's right.

Out for an evening stroll, a priest was shocked to spy one of his parishioners draped drunkenly around a lamp post.

For shame," said the padre. "Young man, what's gotten into you?"

"Three Fathers, feather."

"Papa, there's a woman peddler at the door."

"Tell him to beat it. I got one too many already."

First Drunk: When I was born, I only weighed 3 pounds.

Second Drunk: Did you live?

First Drunk: Yeah, you oughta see me now.

First man How do you remember people's names?

Second man: Well, I associate them. For instance. Mrs. Womack has a large stomach. I remember Womack-stomach.

Next day, the first man met Mrs. Womack on the street and said, "Hello Mrs. Kelly."

Liability, Limited? "Is this the Fidelity Insurance Company?" asked an anxious female voice.

"It is."

"How much do you charge to insure my husband's fidelity?"—*Laughter Is Legal.*

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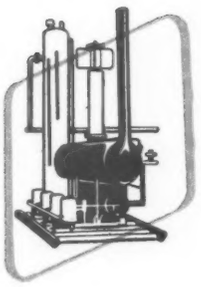

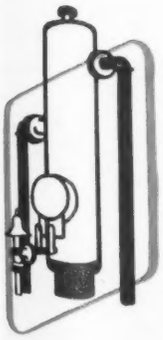

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EXPORT SALES

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Oil and Gas Trade News

Petro-Chem Named As Allis-Chalmers Dealer

The Petro - Chemical Equipment Company, Inc., 2609 Sunset Boulevard, Houston, Texas has been named a dealer in a portion of Texas for Allis-Chalmers motors, controls, blowers, compressors, and Texrope drive equipment. Area served by the new dealership includes that south of and including Burleson, Brazos, Grimes, Walker, and San Jacinto counties, east of and including Washington, Austin, Colorado, Wharton and Jackson counties, and west of and including Montgomery, Harris, and Galveston counties.

Houston Firm Is Agent

The Houston Belting and Supply Company has been named a dealer for Allis-Chalmers controls in 17 east central and southeastern Texas counties. Area served by the firm includes the counties of Burleson, Brazos, Grimes, Walker, San Jacinto, Washington, Austin, Colorado, Wharton, Jackson, Montgomery, Harris, Galveston, Matagorda, Fort Bend, Waller, and Brazoria. Principles in the company are J. O. Long, president; D. J. Wilson, vice president; Paul Long, secretary-treasurer, and Roy Long, sales manager.

Diesel Repair Shop Set Up

Another new, modern diesel repair shop, the eleventh in a network serving Texas, Louisiana, Oklahoma, and Kansas, has been opened by Cummins Sales and Service, Inc., at Pharr, Texas. A new fleet of specially equipped, panel type service trucks, ready to go wherever and whenever a Cummins diesel needs service, has been installed. R. G. Barnes, formerly with the company at New Orleans, Louisiana, will be district service manager at Pharr. Other appointments announced include J. M. Dickey, Jr., from the Oklahoma City shop, as parts manager, V. J. Mikell, diesel mechanic from the Houston shop, service mechanic, and Troy L. Weaver as warehouseman.

Koppers Plans New Plant

Koppers Company, Inc., has taken an option on 158 acres of land at Fontana, California, and contemplates construction of a plant there for the making of enamel pipe coatings and roofing materials. The proposed site is adjacent to the Kaiser Steel Company plant and it was reported that Koppers plans to use pitch made from tar obtained from Kaiser Steel coke ovens, processing it into high-grade enamels for pipe coatings, etc.

Expansion Program Underway

The half-way point on a million dollar expansion program has been reached by the L. B. Foster Company, suppliers of railroad trackage, steel sheet piling, and pipe. Begun in 1949, the program is designed to keep costs as low as possible through increased mechanization and utilization of improved handling and fabricating techniques, Foster said. Completely new warehousing facilities have been finished at Foster's Chicago plant, which is regarded as the best equipped warehouse of handling and fabricating rail, steel sheet piling, pipe, and related items.

Hilliard Names New Agent

The Hilliard Corporation, Elmira, New York, manufacturers of Hilco lube, fuel, and industrial oil filters, reclaimers, and purifiers, has announced the appointment of the Betz Engineering Sales Company, New Orleans, 13, Louisiana, as a new representative. The Betz Engineering Sales Company will cover the territory of Louisiana, Mississippi, and Southern Arkansas. They will act as agents for the full line of Hilliard-Hilco lubricating, filters, reclaimers, purifiers. A. W. Betz is head of the Betz company.

United Supply and Manufacturing Company of Tulsa held its annual sales meeting in Tulsa recently. Executives and representatives attending were, top row: C. A. Kennedy, H. C. Thornton, L. W. Moore, Paul Smith, E. F. Geary, F. W. Fisher, M. W. Brown, W. T. Hughes, C. G. King, Jr., J. L. Smith, H. B. Gutelius, Frank Wood, Clifford Gilbert, John Gilmartin, Jack Schwartz, R. N. Jones, George Schwenker, Ben Reagen. Front row: W. H. Huey, James Reed, Glenn Wilson, L. V. Jones, R. B. Northrup, H. B. Gutelius, Jr., B. S. Vavra, A. R. Brown, Don Torrance, O. O. Raney, V. R. Lemmons, and W. B. Burch. Everyone who attended the meeting agreed it was very successful.

Irl Spangler Rodney S. Durkee Arthur Zschokke George Turechek

Rodney S. Durkee, Lane-Wells president, with three employees to whom he has just presented special achievement awards.

Lane-Wells Honors 3 Men

Lane-Wells recently held a special dinner in Los Angeles to honor three employees whose inventions have made outstanding contributions to the company's products and services. Irl Spangler, Arthur Zschokke, and George Turechek each received checks for substantial amounts in addition to the regular awards previously presented them. The checks were a special award by Lane-Wells, presented by Rodney S. Durkee, president.

Rockwell To Get New Plant

The Rockwell Manufacturing Company of Pittsburgh will build a new 150,000 sq ft manufacturing plant in Tupelo, Mississippi. Rockwell Manufacturing Company, a diversified organization with 14 plants across the country, builds a wide variety of products. Among them are valves, gas meters, regulators, power tools, etc.

Emsco Division Holds Annual Sales Meeting

With field men and district managers present from 14 Mid-Continent and Rocky Mountain states and executives on hand from the West Coast and Texas, the D+B division of Emsco Derrick and Equipment Company held a two - day annual sales meeting in Houston recently.

W. C. McKinder

William C "Bill" Kinder, vice president in charge of the D+B division, in opening the meeting declared the company's sucker rod and deep well pump sales in 1950 had been the greatest in its history, which covers more than 30 years.

In his opening remarks to the sales group, he stated that the company's new plant at Garland, Texas, is operating at full capacity. The plant is now beginning its second year of operation.

Executive offices of the D+B division were moved from Los Angeles to Garland a few weeks ago. The remaining key offices are scheduled to be moved by mid-year.

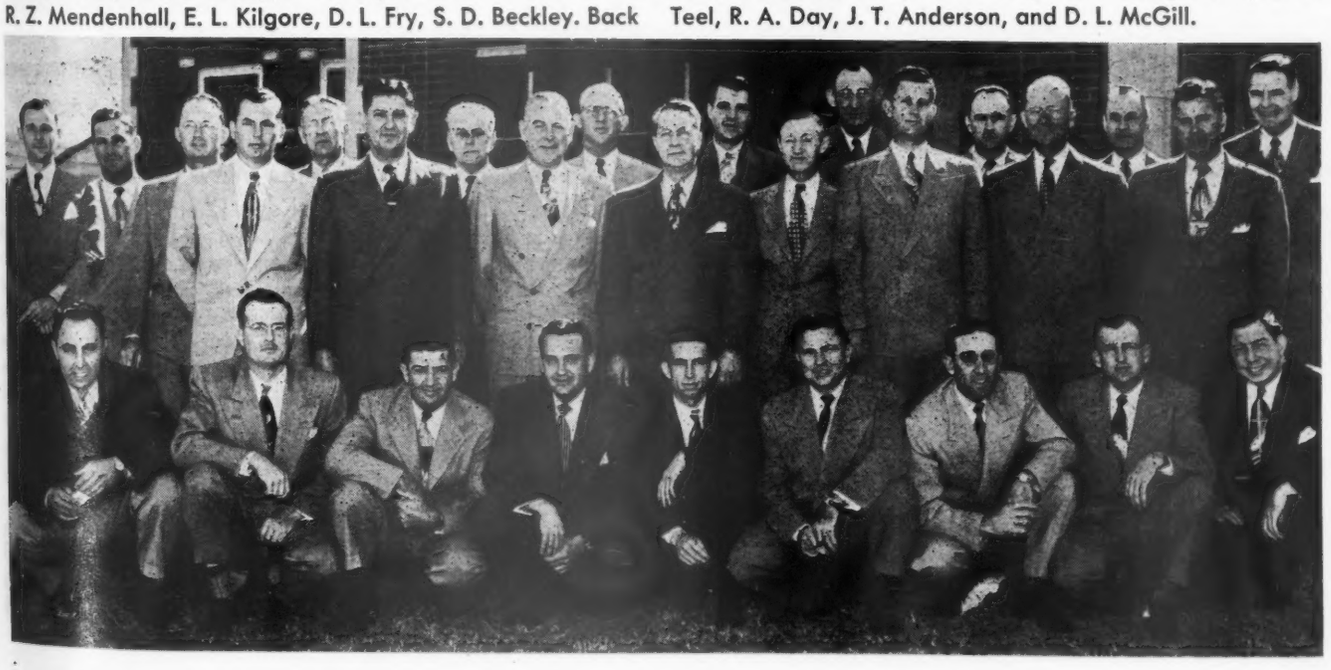
Heavy Equipment Shipped

The heaviest single railroad shipment ever made from Houston, Texas, as well as the heaviest piece of petroleum refinery equipment ever shipped by rail anywhere, left south Texas recently. It was a 49-tray depropanizer, 13 ft 4 in. in diameter by 120 ft long, weighing 601,236 lb. It was fabricated in the Houston plant of Wyatt Metal and Boiler Works. In order to successfully handle this cargo of more than 300 tons, two special built, heavy duty railroad cars were brought into Houston. The middle car served as an idler to take care of trackage curves.

New District Sales Office

The Patterson Foundry and Machine Company of East Liverpool, Ohio, has opened a new district sales office in Denver, Colorado, with Robert Alldredge and William Horblit in charge. This new sales office, situated in the Majestic Building, has been established to provide faster, specialized service to the chemical processing industries in Colorado, Utah, New Mexico, and Wyoming.

Representatives, executives, and field men attended the Guiberson Corporation's 3-day sales meeting held in Dallas, Texas recently. They are, front row: R. L. Lindsay, C. E. Lance, H. M. Cherry, L. T. Ferguson, E. W. Nolan, Jr., R. Z. Mendenhall, E. L. Kilgore, D. L. Fry, S. D. Beckley. Back row: R. L. McAdams, R. J. Foreman, A. E. Brummett, B. M. Matthews, C. L. Forcum, O. A. Hess, G. P. Thomson, H. S. Zane, Jr., D. B. Craver, A. P. Smith, D. L. Moss, R. H. Washburn, Frank Bridwell, E. E. Embury, J. P. Killingsworth, C. A. Teel, R. A. Day, J. T. Anderson, and D. L. McGill.



L. E. Elsener, Chicago Bridge and Iron; P. C. Jurs, S&J; Oliver Johnson, Standard of California, attend S&J plant opening.

S & J Opens New Addition

Shand and Jurs Company has just announced the opening of a new addition to its Berkeley, California plant, and home offices. Adjoining its present building, the new two-story addition will provide about 12,000 more square feet of floor space and represents an investment of about $150,000. Shand and Jurs entire manufacturing activities are carried on at its Berkeley plant, but factory branch sales offices are maintained at New York, Chicago, Houston, Tulsa and Los Angeles, with representatives in Seattle, Vancouver, Montreal, Caracas, and Buenos Aires.

Planning Board Set Up

A new Planning Board, responsible to the chairman, has been established by Johns-Manville Corporation. Composed of a number of senior officers of the company, its purpose is to seek opportunities to expand the business, analysis of over-all company policy, and coordination of activities of the various divisions. Clifford F. Rassweiler has been appointed vice chairman of the board, a newly created office. He has been delegated full responsibility for organization and direction of the new Planning Board.

The new president is L. M. Cassidy, who has been vice president for Sales since 1946. Cassidy, who joined the Johns-Manville organization in 1926, succeeds R. W. Lea who retired as president and director on January 31, 1951. A. R. Fisher, vice president for production and general manager of asbestos fibre division, has been elected a director of the corporation.

Cleco Agents Named

The Cleco Division of the Reed Roller Bit Company Houston, has announced the appointment of Olson Equipment Company, Minneapolis, Minnesota, as distributors of Cleco products in that area. The division also announced the appointment of Gil Boers Equipment Company, Chicago, Illinois, and Airline Equipment Company, Philadelphia, Pennsylvania as distributors in these areas. They will maintain complete stocks of Cleco parts and accessories.

Stearic Acids Put in New Powder Form

Emery Industries, Inc., announces the availability of all grades of Emersol stearic acids in a new "extra-fine" powdered form. These new powders represent the finest particle size stearic acids available. Laboratory screen test results for these new powdered Emersol Acids show that 99.5 per cent pass through a U. S. No. 30 sieve (0.0232 in. openings) and 95 per cent through a U. S. No. 100 sieve (0.0059 in. openings). This is compared to typical material heretofore available of which 96 per cent passes through a U. S. No. 30 sieve and only 70 per cent passing through a U. S. No. 100 sieve. In most cases this finer particle size improves performance and increases efficiency.

New Method Facilitates Horsepower Determination

Determination of horsepower input of centrifugal pumps has been simplified and made considerably more accurate than the calibrated motor method by means of electric strain type torquemeters, plus highly accurate speed measuring equipment of a new type, and other innovations. Time and labor of testing pumps are expected to be cut by at least 60 per cent in the laboratory of Allis-Chalmers Manufacturing Company where the new equipment is installed. Torque is measured by a Baldwin SR-4 torquemeter, which is based on SR-4 bonded resistance wire strain gages. These gages are bonded to a reduced section of a special alloy steel shaft at 45 deg. with longitudinal axis. In this position they respond to the maximum torsional strains resulting from applied torque.

Hercules Office Moved

The San Francisco office of Hercules Powder Company has been moved to the Standard Oil Building, 225 Bush Street. The company's headquarters were formerly at 256 Montgomery Street. The office handles sales of products in the Bay area.

New home of Whitney Chain Company in Los Angeles, California. A. J. Swisler, district manager, will be in charge of the new headquarters of engineering sales.

New Branch Established

The Whitney Chain Company of Hartford, Connecticut, one of the oldest and widely known chain manufacturers in the industry, has occupied its new office and warehouse building at 5400 Pacific Boulevard, Los Angeles. Under the direction of A. J. Swisler, district manager, the modern headquarters will function as the engineering sales and service outlet for the complete line of Whitney power transmission and conveying chain, couplings, keys, and sprockets throughout Southern California and Arizona, with facilities for giving emergency service to all points along the Pacific Coast.

Occupies New Building

West Coast Engine and Equipment Company, distributors of General Motors diesel engines to the construction, industrial, marine, and petroleum fields in Northern California, increased its sales and service facilities when it moved into its newly completed building in Albany, California. The new building is on Eastshore highway about one mile from the company's former headquarters in Berkeley.

According to M. C. Wright, president of the company, floor space will be increased to over 15,000 sq ft with 30,000 sq ft of additional ground space available for building.

Hagn Addresses Conference

H. J. Hagn, vice president and general manager of Well Equipment Manufacturing Corporation, Houston was one of the principal speakers at the Houston Regional Cost Conference at the Shamrock Hotel. His discussion of "Simplified Manufacturing Job Cost for the Oil Tool Industry" was a case study of job cost applied to equipment manufactured for the industry. The three-day conference was attended by approximately 500 members of the association, including national officers and directors from New York City. On the program with Hagn were Jesse G. Kline, chief accountant, Atlantic Refining Company, Philadelphia; D. M. Sheehan, vice president and controller, Monsanto Chemical Company, St. Louis; William B. McCloskey, president of the National Association of Cost Accountants and Controller of Davison Chemical Corporation, Baltimore, Maryland, and Paul C. Taylor, professor of accounting, Tulane University.

H. J. Hagn

New Agents Named

The Cleco division of the Reed Roller Bit Company, Houston, Texas, has announced the appointment of Equipment Sales Company, 720 South 19th Avenue, Phoenix, Arizona, as distributors of Cleco products in that area. In addition to handling the full line of Cleco Pneumatic Tools, Equipment Sales Company will maintain complete stocks of Cleco parts and accessories.

Lane-Wells' New Locations

Lane-Wells has established one new truck station and changed locations on three others. Sterling, Colorado, is the site of the new station, which is situated at 631 North Third Street. With the district office at Casper and the Cody station, this addition gives Lane-Wells three points from which to serve the Rocky Mountain area. Operator of the station is James K. Wagoner, who has been with Lane-Wells for the past 3 years.

The Arklatex district office has been moved from the Old Benton Road location to new and enlarged quarters at 5000 Greenwood Road, Shreveport, Louisiana. All personnel remain the same at the new district headquarters of which K. K. Cage is superintendent.

The Houma, Louisiana, sub-district office has been moved from Broad Street to the recently built location three miles north of Houma on Raceland Highway No. 90.

The Jacksboro Truck Station has been moved to Bowie, Texas, in the North Central Texas District. Warren W. Lambert, who began working for Lane-Wells in 1944 is superintendent.

Field Store Holds Opening

Mid - Continent Supply Company's newest field store, situated at Brownfield, Texas, was formally opened recently with an open house and barbecue at the store. An estimated 1500 guests attended. Ken W. Davis, president of Mid - Continent, announced that the new store is completely stocked with the newest equipment, and is offering 24-hour service. At the same time he announced the appointment of A. A. Pike, former store manager at the company's Fullerton, Texas store, as Brownfield store manager. Other personnel for the new store includes L. E. Baker as field salesman; B. C. Flores, from the Odessa, Texas store; M. H. Hughes, Jr., of the Sundown, Texas store; M. B. Harlan, Jr., and L. O. Lilly from the Fullerton store and Robert Schmidt as warehousemen. The new store will be under the supervision of West Texas - New Mexico Division Manager T. P. Tarwater with W. W. Arnold as district manager.

B S & B Appoints New Sales Representatives

The following new representatives of the Black, Sivalls and Bryson, Inc., safety heads are:

Alabama: Equipment Service Company, Inc., 617 North Ninth Street, Birmingham, Alabama.

Georgia: F. J. Doyle, James G. Nichols Company, 401 Georgia Savings Bank Building, Atlanta 3, Georgia.

North and South Carolina: W. D. Simons, Jr., Mec-Tric Control Company, P. O. Box 354, Charlotte 1, North Carolina.

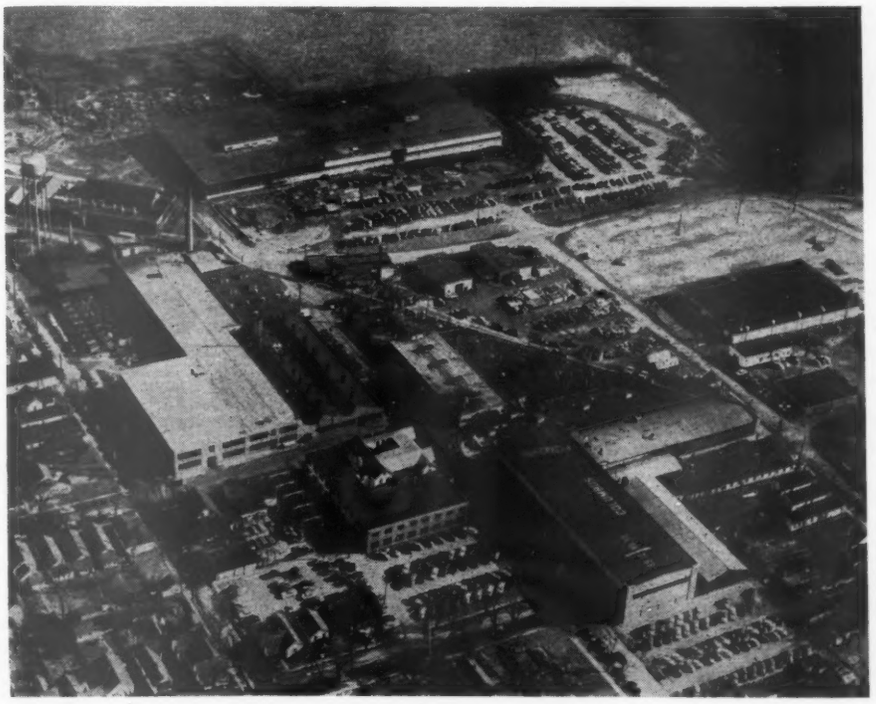
Utah, parts of Wyoming, Idaho, and Nevada: Specialty Sales Company, 208 South West Temple, Salt Lake City, Utah.

Parts of Tennessee, Mississippi, Arkansas, and Kentucky: W. M. Ross, C. J. Gaskell, C. J. Gaskell Company, Inc., 501-502 M & M Building, Memphis, Tennessee.

Knoxville Office Opened

A new branch office of The Foxboro Company has been opened at 618 West Church Avenue, Knoxville, Tennessee. Marvin L. Cleaton, Jr., formerly in charge of the company's office at Columbus, Ohio, has been transferred to become branch manager at Knoxville. Until now, manufacturers in the Knoxville area have been served by the Foxboro company office in Atlanta, Georgia.

Cummins Engine Company, Inc., Columbus, Indiana, makers of lightweight highspeed diesel engines is nearing completion of the new Stores Center Building, upper center. The fuel pump building, left center, will be expanded by 9600 sq ft, increasing the size of the plant by more than 30 per cent.



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on crawlers or rubber, check **KOEHRING CRANES**

Whether your oil field operating conditions demand sure-footed crawler traction to lick toughest mud and grades . . . or require speed and mobility of rubber tires to cut travel time between widely-scattered jobs . . . it will pay you to check the extra lift capacities of Koehring crawler-mounted and rubber-tired cranes.

In lift crane service, the heavy-duty 304 (above) safely handles up to 25 tons . . . Koehring 205 (right) lifts up to 10 tons, depending on type of mounting. Both the ¾-yard 304 and ½-yard 205 are readily convertible from lift crane to clamshell, dragline, hoe or shovel on crawlers or rubber tires. Two larger Koehring sizes on crawlers provide 1½ and 2½ yard dipper capacities . . . 36 and 79½-ton lift capacities.

There's a Koehring size and type best suited for you . . . you'll find your local Koehring distributor ready to analyze your requirements and make recommendations to your best interest. See him soon.

KOEHRING COMPANY
Milwaukee 16, Wis.

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Oil field "handyman"... KWIK-MIX 3½-S DANDIE®

POWER WHEELBARROW . . . Kwik-Mix Moto-Bug® has full power forward and reverse . . . "no push, no pull". Climbs 20% grades fully loaded. Operator rides on rear step. Dual steering wheels standard, dual drive wheels optional. Has 10 cu. ft. hopper, 1200 lb. flatbed, fork lift or scraper blade.

3-S DANDIE concrete mixer with non-tilting, end-discharge drum has power-raised skip, exclusive blade-and-bucket double-mixing action . . . automatic water-measuring system. Tilted Flow-Line Discharge Chute pours full batch in 7 seconds. Other large size Kwik-Mix Dandie concrete mixers include 11-S and 16-S. Send for more facts.

QUICKLY PORTABLE ON LOCATION, SPEEDS SCATTERED MIXING JOBS

For laying concrete slabs, pouring footings, and handling other widely-scattered mixing jobs around refineries, in plant yards, at booster stations or drill sites, here's a portable "handyman" for on-the-spot mixing. Kwik-Mix 3½-S Dandie mixes high-quality concrete fast, at low cost, anywhere on your property. It's portable as a wheelbarrow. Balanced light weight, low center of gravity, roller-bearing wheels and handy push-down tow pole provide easy, one-man spotting on the job . . . and give smooth, fast towing job to job. Easy charging height of 3½', double mixing-folding action, and multiple V-belt drive are a few of the many other advantages worth checking on this utility-size 3½-S Dandie . . . 3 types: end discharge, tilting or non-tilting drum, and side discharge, non-tilting. See your Kwik-Mix distributor, or send for bulletin today.

Mail to:

KWIK-MIX COMPANY Port Washington, Wis.

Send bulletins on: ■ 3-1/2-S ■ 6-S ■ 11-S ■ 16-S Dandie Concrete Mixers

NAME _____

COMPANY _____

STREET _____

CITY _____ STATE _____

■ Also send bulletin on low-cost Moto-Bug. (Koehring Subsidiary)

National Supply's Figures Show 1950 Income Increase

With the oil industry expected to surpass last year's record achievements, both in the number of wells and footage drilled, general pipe sales in 1951 should continue at current high levels and possibly exceed the 1950 volume, A. E. Walker, president of The National Supply Company, Pittsburgh, reported recently. Walker reviewed last year's operations and presented the outlook for this year in the company's annual report for 1950. Pointing out that the company's prospects for 1951 are good, he stated that changing international conditions have eliminated the possibilities of a world surplus of oil and that record production should maintain its accelerated pace.

The company's sales in 1950 were $156,262,538, as compared with $130,885,882 in the previous year. Net income amounted to $8,367,465, a gain of $2,706,874.

Dowell Gets New Lab

A new district laboratory has been opened by Dowell Incorporated in Midland, Texas, to operate as a branch of the main chemical research laboratory in Tulsa, Oklahoma. The Midland laboratory is fully equipped for complete testing of all types of oilfield samples. James O. Means, who has been employed as a research chemist in Tulsa for several years, has been transferred to Midland to be in charge of the new laboratory.

Opens New Office

Arcos Corporation, manufacturer of stainless, low alloy, high tensile, and non-ferrous electrodes, Philadelphia, Pennsylvania, announces the opening of a west coast office and warehouse in Los Angeles. B. E. David has been appointed district manager. This branch office is situated at 427 South Western Avenue.

Rockwell Sets Up New Division

The immediate organization of a separate division at the Freeport, Illinois, plant of Rockwell Manufacturing Company to fabricate armor plate was announced by W. F. Rockwell, Jr., president. The armor plate fabrication will occupy several of the existing buildings at the company's Arcade plant in Freeport and will operate as the Freeport division, independently of the Arcade division, which will continue to produce wood and metal working power tools.

New general manager of the Freeport division will be C. C. Shenkle, who has been general manager of the Pittsburgh-DuBois division, DuBois, Pennsylvania, where gas meters and regulators are manufactured. Shenkle will be succeeded at DuBois by William T. Kiehl, formerly assistant general manager. At Freeport, John Osberg will continue as general manager of the Arcade division.

Standco to Produce New Clutch Facings

Standco Brake Lining Company, Houston, Texas, has now entered the clutch facings field. According to an announcement by C. W. Hanslip, Standco president, "Our company is now producing a new heavy-duty clutch facing in both the gear tooth and plain discs types for use in the oil production, marine, earth-moving, and heavy transportation equipment industries."

Foster Wheeler to Export Generator, Cooling Towers

An order recently received by Foster Wheeler Corporation, New York, calls for two size AG-30 water-tube package steam generators, which will be packed for export and shipped completely assembled from the company's Dansville Works. The order was received from International Petroleum Company, Ltd., Toronto, Canada, with the ultimate destination as Peru. These boilers are the largest size package generators manufactured and the largest Foster Wheeler has ever packed for export shipment with all auxiliary equipment mounted.

Foster Wheeler also has been awarded a contract by the California Texas Oil Company, Ltd., acting on behalf of Refineria de Petroleos de Escombreras S. A., for one four-cell induced draft cooling tower. This tower, which is designed to cool 13,500 gpm of water will be erected at the customer's oil refinery erected at Cartegena, Spain. The tower will be constructed of select heart grade California redwood with brass hardware and will employ monel fan blades and totally enclosed fan cooled motors.

Deluxe Sets Up New Industrial Sales Division

DeLuxe Products Corporation of LaPorte, Indiana has established a separate oil filter and industrial sales division on its line of gasoline and diesel engine oil filters and replacement cartridges. The new sales division will be headed by J. F. "Jimmie" Austin of Dallas, Texas, formerly DeLuxe representative in the southwestern area. The division will operate under the general supervision of R. E. Archer, who is oil filter sales manager for DeLuxe.

Hunt Tool Buys Patents

T. N. Hunt, president of the Hunt Tool Company, Houston, Texas announces the purchase of the Turney draw-works patents. Hunt Tool is now manufacturing the draw-works, with many improvements, in its Houston plant in addition to its present line of swivel joints, coring tools, drilling bits, and its new hydraulic pulling tool.

T. N. Hunt

RCA Expands Sales Force Of Engineering Products

Plans for extensive promotion of RCA's entire line of two-way mobile radio communications and microwave relay equipment during the coming year were announced recently by C. M. Lewis, sales manager of the broadcast and communications section of the RCA engineering products departments. Twelve additional field sales representatives have been appointed, and Dana Pratt, former sales manager for RCA broadcast transmitter equipment, has been named manager of the communications and microwave sales group. New field sales representatives and their regional headquarters are: Wayne L. Babcock, Hollywood; A. Fischer, Camden; George A. Griffith, Dallas; T. W. Kennedy, Chicago; Arthur E. Konick, New York; Dixie B. McKey, Dallas; Adron M. Miller, Chicago; G. E. Rand, Atlanta; Donald O. Reinert, Camden; C. Kenneth Sulger, Cleveland; Douglas J. Upton, Hollywood; and J. M. Walters, Atlanta. George W. Pettengill, veteran RCA communications sales engineer, has been named general assistant to Pratt. Pratt is a native of Kansas and holds an engineering degree from the University of Kansas.

Dearborn Chemical Moves

Dearborn Chemical Company, Chicago, manufacturer of NO-OX-ID rust preventives and industrial boiler feedwater treatment, has moved into new and modern air-conditioned offices in the Chicago Merchandise Mart. President Robert A. Carr announced that the expansion will add an additional 5000 sq ft of office space. The new office, to be situated on the third floor of the Mart, will also house Dearborn's plumite division, the company's household drain cleaner, and Electro-Chemical Engineering Corporation, Dearborn subsidiary.

Trade Personals

Carl Blom has been elected a vice president of Byron Jackson Company.

Carl Blom

Joining Byron Jackson in 1924, Blom steadily advanced and became chief engineer of the pump division in 1940. He graduated from the Trondheim Institute of Technology, Trondheim, Norway in 1922, where he specialized in hydraulic engineering. After serving one year as an instructor in this institute, he came to the U.S.A. and joined Byron Jackson as a pump design engineer. Many important pumping projects include units that have been designed by Blom. Topping the list are the world's largest pumps for Grand Coulee Dam—six units, each to deliver 720,000 gpm at 300 ft when driven by its 65,000 hp electric motor.

C. M. ("Buck") Lewis has been named manager of the broadcast and communications sales section of the RCA Engineering Products Department. Since 1948, Lewis has been manager of broadcast field sales activities for the engineering products department, supervising the activities of RCA's broadcast and television equipment sales engineers in 6 regional offices throughout the country. He succeeds A. R. Hopkins, general sales manager. Lewis served as commercial manager for radar equipment during the war.

Jim Witovec, who began as an apprentice machinist with Oil Center Tool Company, 1930, climaxed a career of more than 20 years with the oil equipment manufacturing company recently when he was elected a vice president and director of the company.

Jim Witovec

Witovec was the 12th employee hired by Oil Center Tool whose total employees today number 225. After Witovec became a machinist, he later moved into set-up and time study work on machine operations, and became shop production superintendent in 1948.

Joe C. Shaw, sales engineer with the Young Radiator Company is now affiliated with the J. R. Meek Company, Tulsa, Oklahoma. Shaw has been associated with Young since 1942. The J. R. Meek Company is the exclusive distributor of Young heat transfer equipment in the Mid-Continent area.

J. M. Browning, the American Meter Company, has been transferred from its wholly owned subsidiary, Westcott and Greis, Inc., Houston, Texas, to the American Meter Company's New York office. Browning will assist **A. B. Cloud,** district sales manager.

J. M. Browning

Robert C. Becherer was elected vice president of Link-Belt Company at a meeting of the board of directors recently. All officers who served last year were re-elected. Becherer, who joined Link-Belt in 1923 upon graduation from Purdue University in chemical engineering, has been general manager of the company's Ewart plant in Indianapolis since 1947 and will continue to hold this position.

Delphine S. Byrne has been advanced to the position of advertising and sales promotion manager of The H. M. Harper Company, Morton Grove, Illinois, manufacturer of non-ferrous and stainless steel fastenings. Miss Byrne has been associated with H. M. Harper for 9 years and leaves the sales department for her new position.

Delphine Byrne

Leslie E. Sebald, vice president-engineering of The Griscom-Russell Company, died suddenly on March 5. Sebald joined the company in 1919, and became chief engineer in 1939. He had been vice president-engineering since 1949. **Oscar W. Heimberger** will continue as chief engineer of the company. Heimberger has been with the company since 1923, after graduating 3 years previously from Ohio State University.

C. B. Wright

A. M. Taylor

A. M. Taylor, formerly with Bethlehem Supply Company in Oklahoma, has been added to the Oil Center Tool Company sales organization and will make his headquarters in Oklahoma City. **C. B. Wright,** formerly in the O-C-T Oklahoma City sales office, has moved to Dallas. He will serve the North Texas territory from his Dallas headquarters.

Herman S. Simmons, 53, sales manager of Herb J. Hawthorne, Inc., Houston, Texas, died suddenly at the Highland Hospital, Shreveport, Louisiana, March 6. A well known figure in the drilling industry, Simmons joined Hawthorne as sales manager in 1948. In this capacity his work carried him to all parts of the United States, Canada, and Mexico, where he made many personal friends among the personnel of oil companies, seismograph companies, and drilling crews.

Cooke Bausman, Jr., has been named manager of the sales department, central staff of Koppers Company, Inc. Bausman joined Koppers in September 1948 as assistant manager of the sales department and since last November 1 has been acting manager of the department. A native of Pittsburgh, Bausman attended Shadyside Academy and the University of Pittsburgh, specializing in the fields of finance and business management. Upon graduation he joined Mellon Securities Corporation.

John R. Hartley, Builders-Providence, Inc., Providence, Rhode Island, was elected a vice president of the company. Hartley has been associated with Builders for 23 years, the last three of which he has been manager of project sales. Hartley will continue in charge of engineered project sales both in the water and sewage fields and in the problems of water and waste treatment in a variety of industries.

John Hartley

▸ **W. O. Calvert,** export sales representative for Thornhill-Craver Company, Mission Manufacturing Company and A-1 Bit and Tool Company, all of Houston, Texas, sailed from New York on March 21 for an extended tour of oil fields in England, Holland, West Germany, France, Italy, and the Middle East.

▸ **M. E. Montrose** of Houston, Texas, vice president and member of the board of Hughes Tool Company, was elected to the board of directors of Welex Jet Services, Inc. at its annual stockholders' meeting held in Fort Worth on March 2.

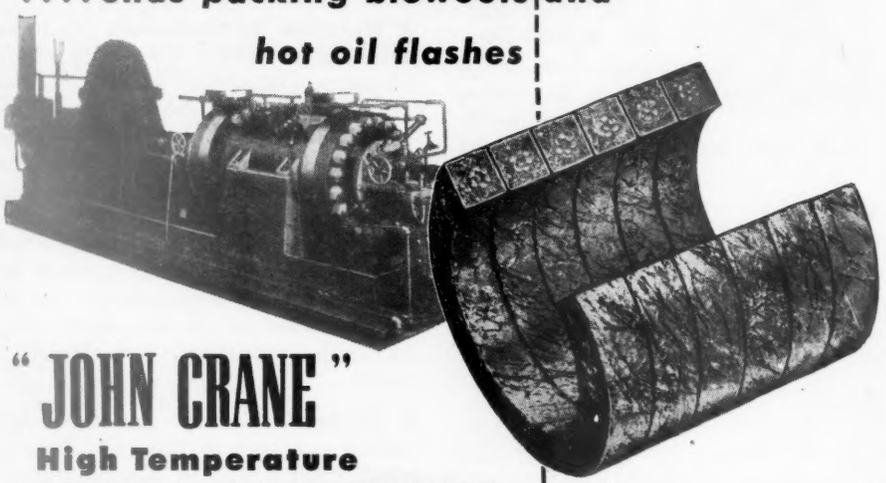
▸ **Thomas H. Shartle,** president, Texas Electric Steel Casting Company, Houston, Texas, is the winner of the Lorenz Memorial Gold Medal for 1950, awarded for distinguished service to the steel casting industry. Shartle also was re-elected to a third consecutive term as president and chairman of the executive committee of Steel Founders' Society of America.

T. H. Shartle

Safe and Sure Packing for

HOT OIL CHARGE PUMPS

....ends packing blowouts and hot oil flashes



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METALLIC PACKING

"John Crane" High Temperature Metallic Packings have been developed, as a result of years of extensive research, to withstand temperatures as high as 750°F—discharge pressures of over 800 lbs.—speeds of 3600 rpm or more.

These "John Crane" Packings have been in continuous use on heavy and light hot oil charge pumps for years without maintenance or attention. One user reports..."seven years of continuous service and still as dependable as the day it was installed".

For a truly dependable packing for hot oil charge pumps, specify "John Crane" Style 101-AL. For the *right* combination of "John Crane" Packings to meet your specific needs, consult with experienced Crane Packing Company field engineers.

STYLE 101-AL (Aluminum).

Available in spirals and die-formed rings to specific stuffing box sizes.

Made of continuous thin ribbons of soft aluminum foil, spirally wrapped, crinkled and folded about a small core of pure dry asbestos roving, and squared to desired size.

ADVANTAGES . . . Minimum wear on shaft sleeves . . . Easy adjustment by gland takeup . . . Operation at highest temperatures . . . Easy cutting of rings from stock spirals.

SERVICE . . . High temperature centrifugal hot oil charge pumps . . . hot oil valves . . . Diphenyl valves . . . still necks.

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JOHN CRANE

PACKINGS AND MECHANICAL SEALS

CRANE PACKING COMPANY

CHICAGO

Offices in All Principal Cities in United States and Canada

▸ **William R. Wilkinson** has been appointed vice president for sales and **Kenneth W. Huffine** has been appointed vice president for production, Johns-Manville Corporation. Both Wilkinson and Huffine bring backgrounds of wide experience to their new positions and with their promotions, become senior vice presidents of Johns-Manville.

Wilkinson, who has been general merchandise manager of the building products division for the past five years, has had 26 years experience with Johns-Manville in sales and merchandising. He succeeds **L. M. Cassidy,** recently elected chairman of the board and chief executive officer.

Huffine succeeds **A. R. Fisher** who was appointed president on March 2, 1951.

▸ **R. Barney Barnhill** has been named sales representative for Wichita Falls Foundry and Machine Works, Inc. While he will maintain headquarters in Houston, Barnhill will cover the entire oil producing areas in the United States. The company manufactures catheads, air-tube clutches, Rotor Seals, quick release valves, V-belt pulleys, air compression clutches, and water pumps. Barnhill was with Mission Supply for 10 years.

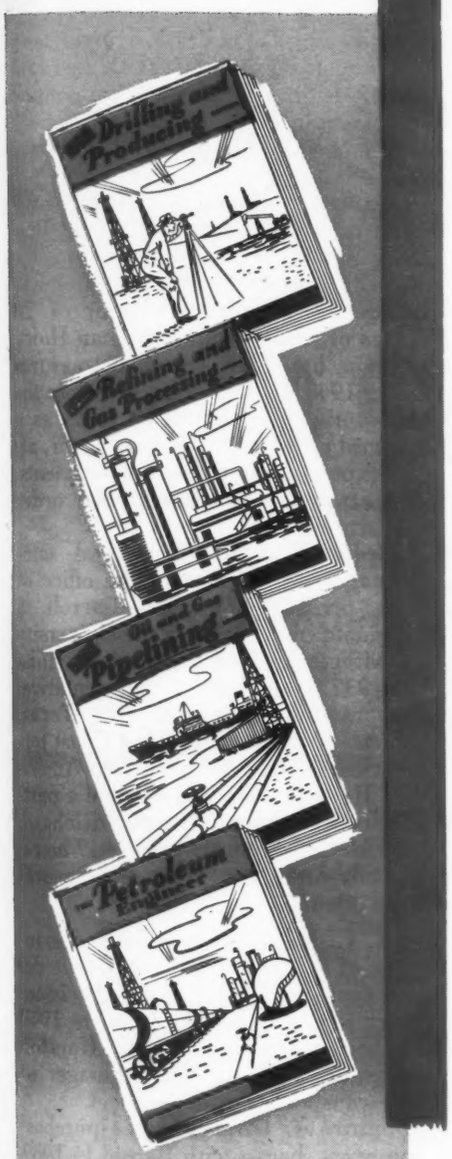
R. H. Owens

R. R. Newquist

▸ **Robert H. Owens** has been elected president and general manager of Roots-Connersville Blower Corporation, succeeding **John Avery** who died unexpectedly on January 13. Owens, a graduate of Purdue University, came to Connersville in 1925 to join the engineering staff of the P. H. & F. M. Roots Company, a predecessor of Roots-Connersville. In 1948 he was elected to the board of directors. **Ralph R. Newquist,** who became vice president in charge of sales in 1946, has been elected executive vice president. He is a graduate of Penn State College.

▸ **W. A. L. Goldsmith** has been named comptroller of the Regan Forge and Engineering Company. For the past 12 years Goldsmith has been associated with the Eastman Oil Well Survey Company of Long Beach as assistant secretary and office manager.

an announcement to our readers



In January, 1949, The Petroleum Engineer introduced four separate editions, to permit editorial selection by individual subscribers. Unique to publishing, this Selective Editions plan is the only one of its kind in the world.

To introduce this new and better editorial plan for readers . . . to permit operating men the industry over to familiarize themselves with PE's four Selective Editions, introductory subscription rates were established, as follows:

introductory rates

Drilling and Producing	**$1 a yr.–$1.50 two yrs.**
Refining-Gas Processing	**$1 a yr.–$1.50 two yrs.**
Oil and Gas Pipelining	**$1 a yr.–$1.50 two yrs.**
Combined (All Divisions)	**$3 a yr.–$5.00 two yrs.**

Throughout the introductory period following their development, reader response to PE's four editions has been spontaneous and gratifying. An avalanche of qualified new subscriptions to the four editions has increased The Petroleum Engineer's "required-title" circulation 33% in two years. Subscribers include operating men throughout the United States and 51 foreign countries.

Effective June 1, 1951, these Introductory Rates will be replaced by permanent subscription rates as follows:

permanent rates

Drilling and Producing	**$2 a yr.–$3 two yrs.**
Refining-Gas Processing	**$2 a yr.–$3 two yrs.**
Oil and Gas Pipelining	**$2 a yr.–$3 two yrs.**
Combined (All Divisions)	**$5 a yr.–$8 two yrs.**

We take this means of bringing to the attention of all readers the effective date of these Permanent Rates. We urge present and prospective subscribers to *act now* on new or advance renewal subscriptions.

Use the Enclosed Subscription Card to secure your New or Advance Renewal Subscription Now while the Introductory Rates are still available.

First **petroleum publication to devote editorial policy exclusively to engineering and method type articles . . .**

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The Petroleum Engineer

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To obtain more information on products advertised see page E-49

R. J. Stoddard | J. F. Bishop | J. E. Carroll | R. C. Marr | J. J. Doyle | E. L. Mohr

Officers of American Hoist and Derrick Company — Baroid Sales Division Promotions

▸ **Robert J. Stoddard** has been elected vice president of engineering, American Hoist and Derrick Company. Stoddard is a graduate of the University of South Carolina with a CE degree and also of M.I.T. with a MS degree. He began his career with American Hoist in 1937 as assistant chief engineer. He was appointed chief engineer in 1947. He has been a member of the board of directors since last year.

James F. Bishop, secretary-treasurer of the American Hoist and Derrick Company, was elected to the board of directors at a recent stockholders' meeting. A veteran of 28 years of service with American Hoist. Bishop has been secretary-treasurer since 1945. He began his career in the accounting department in 1923 as a general clerk and office-boy. Later, after experience in various departments, he was made manager of the order department.

John E. Carroll, general sales manager, was elected to the office of vice president of sales. Carroll, a graduate engineer from the University of Minnesota, joined American Hoist in 1937 as a district representative. He traveled successively the Texas, Chicago and later the West Coast territories. Carroll resigned from American Hoist in 1945 and became a partner in the firm of Harron, Richard, and McCone Company. In 1949 he rejoined American Hoist as general sales manager.

▸ **R. C. Marr** has been named manager of the product procurement department of Baroid Sales Division. Marr joined Baroid in 1936. In 1940 he became manager of the Houston laboratory, and in 1945 manager of the transportation department.

James J. Doyle, named purchasing agent, began with Baroid in 1939 in the Houston laboratory. He became development engineer for the testing equipment and transportation departments in 1945, and engineer on the Gulf Coast in 1950.

Floyd T. Gregory was named manager of transportation and testing equipment departments. He formerly was assistant manager.

Edmund L. Mohr has been appointed general superintendent, Pacific Coast division. Mohr joined Baroid in 1941, and was formerly superintendent of Districts 53-4 in the Bakersfield, California area.

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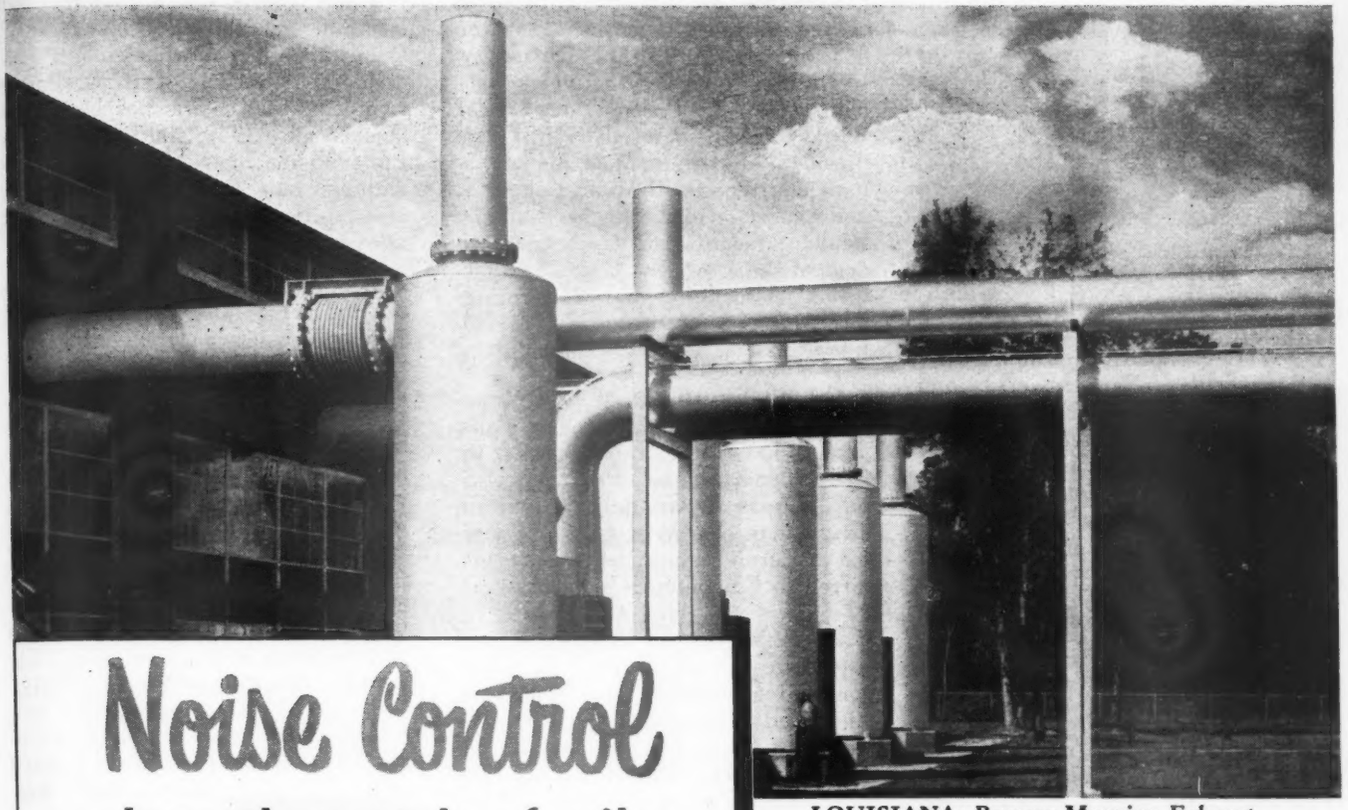
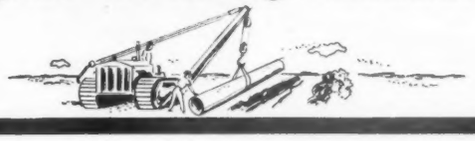


Noise Control

along thousands of miles of Pipe Lines . . . with Burgess-Manning Snubbers



● Across flat prairies, farm land, over hills, across valleys, under surging rivers . . . wherever the ditcher blazed the trail and the welder sweated making "stringer beads," you find pipe lines carrying crude oil or gas. At numerous pipe-line stations along the route, Burgess-Manning Snubbers are quieting the explosive exhaust from noisy internal combustion engines. These Snubbers convert the high-energy slugs of exhaust gases to a continuous flow . . . dissipating their energy to reduce the roar to the noise-level of the surrounding area. Consult the Burgess-Manning engineers, today.

BURGESS-MANNING COMPANY

749 East Park Avenue, Libertyville, Illinois

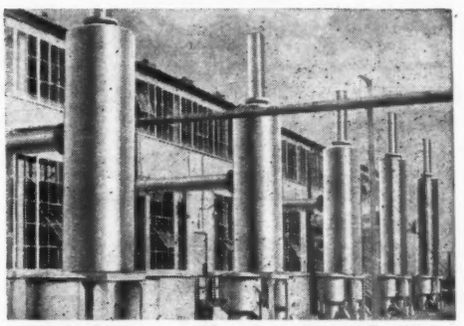
For Prompt Service
Contact Our New
Engineering and Sales Office

BURGESS-MANNING CO.

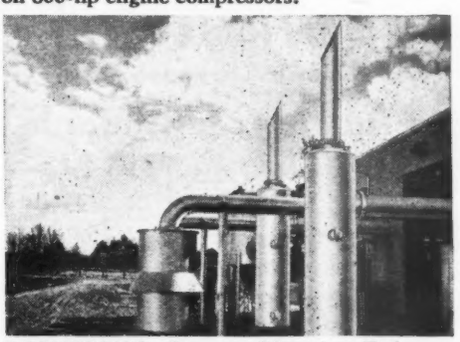
1203 Dragon Street

DALLAS, TEXAS

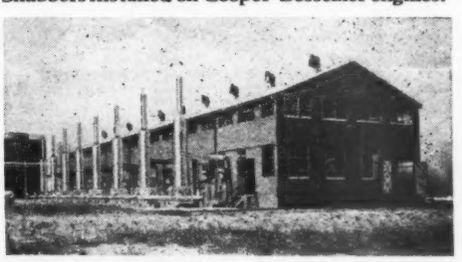
LOUISIANA: Burgess-Manning Exhaust Snubbers installed on gas engine compressors.



KANSAS: Burgess-Manning STL-14 Snubbers on 800-hp engine compressors.



LOUISIANA: Burgess-Manning Exhaust Snubbers installed on Cooper-Bessemer engines.



TEXAS: Burgess-Manning Snubbers on eight 1100-hp gas engines.

D. W. Peake

R. P. McBride

David W. Peake, salesman with S. D. Day Company, Houston, Texas, is a graduate of Yale University and was an inspector with Fish Constructors, Inc., before joining Day. Day Company is agent for Ruberoid pipe line felt, Pittsburgh Coke and Chemical Company coal tar enamels, O.K. glass pipe wrap, and other pipe line specialties.

Robert P. (Pat) McBride has been appointed sales engineer, heavy machinery division, it is announced by R. W. Bayerlein, vice president, heavy machinery division, Nordberg Manufacturing Company. A native of Wisconsin, McBride attended Wisconsin University. He was associated with the Wisconsin Power and Light Company from 1938 to 1942 in the sales department. He joined Nordberg in 1950.

Thomas J. Bannan has been elected to the chairmanship of the board of regents of Seattle University. In addition to his civic activities, Bannan is president of Western Gear Works and associated companies, president of Hallidie Machinery Company and Webster-Brinkley Company, and a director of the Pacific National Bank of Seattle. He has been president of the American Gear Manufacturers' Association and is a former national vice president of the National Association of Manufacturers.

Ed W. Smithson, Wilson Manufacturing Company, Wichita Falls, Texas, has been transferred from Great Bend, Kansas, to Carmi, Illinois. **Louis A. Gosden,** who formerly was in charge of sales and service at Carmi, Ilinois, has been transferred to Edmonton, Canada.

Irwin W. Tyson has been elected executive vice president of O. S. Tyson and Company, Inc., New York City, and **Thomas W. Hall,** vice president. Tyson is a graduate of Cornell University, 1939. This is his 11th year with the agency, founded by his father in 1924. Hall, a graduate of Illinois Institute of Technology, joined Tyson and Company in 1947 as an account manager.

J. R. Lewis has been appointed assistant general sales manager of Quaker Rubber Corporation, Philadelphia, a division of H. K. Porter Company, Inc. Lewis has been with Quaker since 1940, and has served as Philadelphia district sales manager and assistant sales manager. In his new position he will assist the general sales manager.

Lee Fabj has been appointed as district merchandise manager for Oil Well Supply Company's South Louisiana-Mississippi district. Fabj will make his headquarters at the Harvey, Louisiana, store. In his new position he will supervise the stocking and administrative activities in connection with store operations in the district, whose headquarters are located at New Orleans. Fabj joined "Oilwell" in 1943 as a field auditor and was promoted to senior field auditor the following year. He subsequently served as district material supervisor at Wichita Falls, Texas, and Midland, Texas.

J. D. Bradley, formerly with Lufkin Foundry and Machine Company's Great Bend, Kansas, office, has been named sales and engineering representative for the company's new office at Duncan, Oklahoma, to serve the Southwestern Oklahoma territory. Except for his service with the armed forces, Bradley has been with Lufkin at Great Bend since 1941. Prior to that time he attended the University of Oklahoma. Lufkin Foundry makes pumping units and gas engines.

J. D. Bradley

Roger Lewis recently joined the petroleum engineering firm of Cable and Stine. Previously, as an employee of the Bureau of Mines, he had participated in a study, to be published soon, of the southwest part of the Kamay, Texas, field. Lewis is a graduate of the University of Texas in petroleum engineering.

W. M. Holland, manager of manufacturer sales for the industrial power division of the International Harvester Company, was elected president of the Internal Combustion Engine Institute at the organization's annual meeting and election of officers. Holland has been an IH industrial power sales executive since 1948 and has been associated with the company's industrial power division since its formation in 1944. He attended Creighton University at Omaha and the University of Nebraska, finishing in 1928 when he joined Harvester.

for lasting, dependable trouble-free service

● Complete facilities including heavy duty hydraulically tested tank nozzles; efficient double elbow type swing joints that minimize agitation and pressure drop; sturdy steel swing pipe clamps; cables; internal sheaves or cable sheave bracket assemblies complete with bronze gland stuffing box; and internal or external tank winches. Fully descriptive catalog gives full details. *Write for a copy today.*

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THE JOHNSTON & JENNINGS CO.

division of PETTIBONE MULLIKEN CORP.

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MACK TRUCKS

Get Things Done!

● Extra effort—that's the order of the day as American industry swings into high gear to meet the growing demands of the nation's expanding defense program.

Nowhere is this more important than on vital construction work and on the job of keeping raw materials flowing from the mines, the forests and the oil fields.

Here's work that's cut out for Mack trucks... jobs where big Macks show at their best in *extra* strength and stamina, *extra* performance and *extra* dependability.

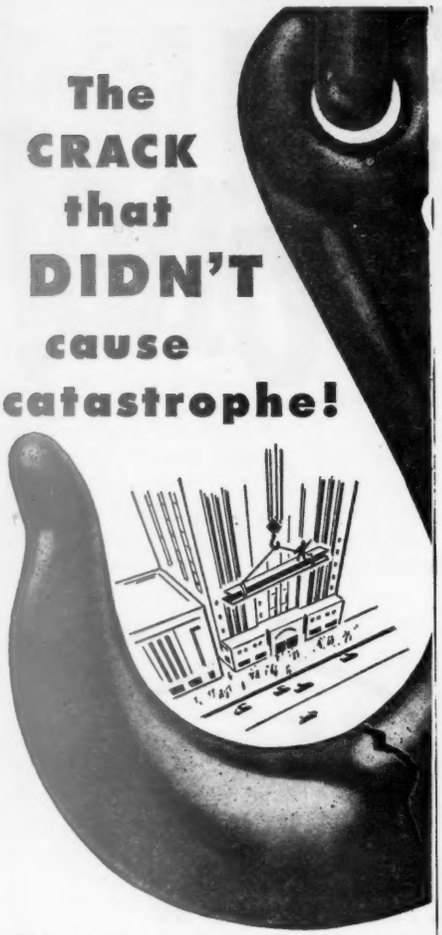
Your nearest Mack branch or distributor will show you how Mack's exclusive design and construction can boost output on your particular job... *get things done* faster and at lower cost. You'll find it's a story well worth hearing.

Mack TRUCKS

...outlast them all

Mack Trucks, Empire State Bldg., New York 1, New York. Factories at Allentown, Pa.; Plainfield, N. J.; Long Island City, N. Y. Factory branches and distributors in all principal cities for service and parts. In Canada: Mack Trucks of Canada, Ltd.

Mack Model LMSWX diesel-powered six-wheeler serving Smulcer Trucking Co. of Wichita Falls, Texas.



When the massive hook for this huge hoist was made it contained a flaw—an imperfection that *could* have caused disaster if not discovered in time—a tiny crack, too minute for human eyes to see.

Inspection with Magnaflux found it—and the faulty hook was repaired *before* it had a chance to fail.

Magnaflux shows up defects in a wide variety of materials—the modern, scientific way. It *instantly* exposes cracks and defects in metals—even when hidden beneath the surface! Magnaflux is low in cost—non-destructive—*and so fast that it detects defects at production line speeds!*

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MAGNAFLUX

detects defects

MAGNAFLUX CORPORATION

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▸ **Floyd C. Myers,** manager of branch operations for Black, Sivalls and Bryson, Inc., is to transfer headquarters from Kansas City to Oklahoma City in accordance with the company's policy of concentrating their oil, gas and refining business at the latter point. Upon graduating from school in 1929, Myers joined BS&B as a clerk in the Tulsa office. He was later transferred to sales and service work in Texas, becoming a branch manager in 1935. Five years later he was made assistant credit manager, assuming the duties of credit manager during the war period. Later he became district sales manager for West Texas.

F. C. Myers

E. O. Dixon T. L. Swansen

▸ **E. O. Dixon** has been named vice president in charge of research and metallurgy and **T. L. Swansen** vice president in charge of manufacturing, for Ladish Company, Cudahy, Wisconsin, manufacturer of a complete line of forged and seamless welding pipe fittings and drop forgings up to 10,000 lb. Dixon has been with Ladish for more than 20 years.

▸ **Frank Pusey** has been assigned automotive service representative of the Eastern district office of Du Pont's petroleum chemicals division. His headquarters will be in New York. Pusey spent 2 years with the Allison division of General Motors as field engineer and 12 years as sales engineer for Pure Oil Company before he joined Du Pont.

▸ **Thomas C. Beattie** has been named general superintendent of Fairless Works of National Tube Company, a U. S. Steel subsidiary. Beattie will manage all operations of the new pipe mills which are being installed by National Tube Company near Morrisville, Pennsylvania. He began his career in the engineering department of the Riverside Works of National Tube Company, eventually becoming superintendent of the pipe mills there.

W. C. Langley A. A. Melnychuk

▸ **W. C. Langley** has been appointed as South American representative for Rector casing and tubing heads, christmas trees, "Fullbore" cementing equipment, Rectorseal, and other equipment, for Rector Well Equipment Company, Inc. Langley, who conducts his own export sales company in South America will represent Rector in the following countries: Venezuela, Colombia, British, Dutch and French Guiana, Ecuador, Brazil, Peru, Bolivia, Paraguay, Uraguay, Chile, and Argentina. Langley organized his own export sales organization in Trinidad, BWI in 1938. In 1943 he moved his headquarters to Barranquilla, Colombia, where his present address is air mail, Apartado Areo, 397, boat mail, Apartado 838.

▸ **Andrew A. Melnychuk** has been named project engineer in the home office, Omega Machine Company, Providence, Rhode Island, manufacturers of chemical feeding equipment.

Melnychuk holds a master's degree in chemical engineering. In his present assignment he will be working on development and research in the problems of chemical feeding as they occur in chemical industry, foods, plastics, petroleum, pulp and paper, water and sewage, etc.

▸ **Thomas B. McMeekin** has been appointed sales and service engineer, heavy machinery division, San Francisco, office of Nordberg Manufacturing Company. McMeekin graduated from Westminister College in 1927 with a degree in chemistry. In 1946 he went into business for himself selling and servicing fuel injection equipment. He joined Cooper-Bessemer Corporation in 1948, setting up facilities for the company's locomotive program on the West Coast. He left Cooper-Bessemer in 1950 and was self-employed prior to joining Nordberg.

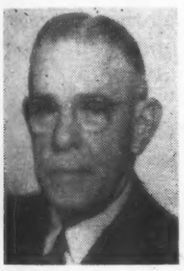
T. B. McMeekin

J. W. McCormick has been named as sales engineer, New York office, 122 E. 42nd Street, for Pacific Pumps Inc. McCormick joined Pacific Pumps in July 1941 following his graduation from the University of Nebraska. In 1948 he was appointed sales engineer in the Los Angeles-San Francisco districts.

J. W. McCormick

C. A. Wagner, with headquarters in Dallas, Texas, has been appointed by The Billings and Spencer Company, Hartford, Connecticut, manufacturer of drop forged wrenches and shop tools, as their direct representative for Texas, Arkansas, Louisiana, and Oklahoma. Wagner is well versed in the problems of industrial distributors, wholesale hardware men, as well as the needs of oil well, plumbing, heating and electrical supply houses.

O. D. Upton has been named district manager for Pioneer Rubber Mills, with headquarters at 228 Irwin-Keasler Building, Dallas, Texas. Most of Upton's 30 years in the industrial rubber business has been spent in the Southwest states. Pioneer Rubber Mills manufactures a complete line of conveyer, elevator, and transmission belting, industrial hose, fire hose, packing, and other specialties. New territory includes Texas, Louisiana, Arkansas, and Western Mississippi.



O. D. Upton

Ralph W. Nichols has recently rejoined Black, Sivalls and Bryson, Inc., as sales manager of their oil and gas equipment division, and will establish headquarters at Oklahoma City. After graduating from Kansas University in 1926 with degrees in engineering, Nichols served as chief engineer with the Wooded Hills Development Company for two years, and as chief engineer with the Darby Corporation for a period of three years. He then joined BS&B. From 1945 to near the close of 1950 he was sales manager for the Richmond Engineering Company.

R. W. Nichols

It's Easier to Adjust CASE Engines to the Oil Flow...

Case Engines are built to pull as strong at reduced speed as at rated speed. This permits wide adjustment of pump speed, to fit the flow, without the bother and cost of changing belt pulleys or gear ratio between the engine and pump. That's why you'll find it easier to adjust Case Engines to the oil flow, and you'll save money on hook-up equipment as well. You'll save, too, on pumping costs because fuel consumption goes down in proportion to speed, and hundreds of extra hours can be added to engine life.

Match Your Power to Your Pumping Needs

See the complete line of Case Engines for oil fields—in horsepower sizes of 61, 42, 28½ and 24. The range of horsepower sizes permits good matching of engine power to your pumping requirements. Be sure to check over the tested Case features that have proved themselves in steady week-after-week pumping. See your Case oil field dealer for full details—or write for name and address of your nearest dealer. J. I. Case Co., Racine, Wis.

CASE ★ ★

E. E. Matheson | H. Gottwald | R. R. Bush | O. W. Barnett

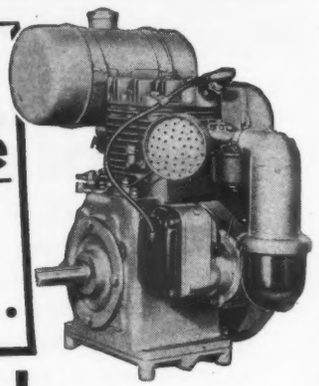
E. E. Matheson, Rockwell Manufacturing Company, has been moved to the Oakland, California, Nordstrom valve plant, where he will assist the factory management by acting as liaison between production, engineering, and sales. He was appointed general sales manager in 1945. **H. Gottwald** will become general sales manager for Nordstrom valves. He began with the organization in 1928 as a sales engineer in the New York district office. He has been successively assistant sales manager of Nordstrom valves and assistant vice president of the company's meter and valve division.

R. R. Bush will be oil field products sales manager. He was employed by the Texas Pipe Line Company before joining Rockwell in 1934 as a sales engineer for the Tulsa district. Shortly before assuming his new responsibilities he was named special representative for Nordstrom valves. **O. W. Barnett** will be sales manager of warehouse and jobber sales. He joined the company in 1934 and was assigned to field work in Oklahoma and Louisiana. In 1950 he was appointed gas products sales supervisor in the Tulsa area and later became assistant sales manager for the Nordstrom division.

C. S. White has been named head of the water treatment department, Dearborn Chemical Company, Eastern division. He replaces **S. H. Opdyke,** retired. **Howard E. Johnston,** also of the Eastern division, has been named head of the NO-OX-ID sales. He succeeds **C. A. Remsen,** deceased. Both men will make their headquarters in New York. **R. O. Benson,** former Chicago representative, has been assigned to the Iowa territory, replacing White. **C. R. Oller,** formerly with Dearborn, has returned to the San Francisco office. **C. C. Dennis,** former service representative in Indianapolis, has been transferred to the Chicago sales staff, replacing **Vincent P. Nobile** who was assigned the New Jersey territory. Another addition to the Chicago staff is **Paul E. France,** formerly with General Chemical Company. Further additions to the sales staff include: **R. H. Derr,** Pittsburgh; **M. H. Jamison,** Chicago; **W. M. Morris,** Pennsylvania; **V. E. Stiers,** Oregon; and **T. Zaggy,** Chicago.

W. E. Brown has been named sales engineer for the Los Angeles district of Pacific Pumps, Inc., to succeed **J. W. McCormick** who has recently transferred to New York. Brown graduated from Iowa State at Ames, Iowa, in 1941 as a mechanical engineer. Since that time he has been employed in various engineering capacities. Since going to California five years ago he has become well known throughout the industry.

Gain More Power Advantage for Your 3 to 6 hp. Units...



Presented here are a few of the basic facts why Wisconsin Heavy-Duty Air-Cooled Engines offer important advantages to the user of power-driven equipment that has to deliver dependable on-the-job service:

1. Rotary type high tension magneto, with impulse coupling, mounted on outside of engine . . . operates as an entirely independent unit that can be serviced or replaced in a few minutes.

2. Self-cleaning tapered roller bearings at both ends of the crankshaft . . . will withstand side-pull or end-thrust without danger to bearings.

3. Maximum torque at usable speeds . . . most desirable on equipment that really has to go to work.

Your Wisconsin Engine distributor or dealer will be glad to co-operate with you in adapting Wisconsin Engines to your requirements. Write for detailed data.

Condensed Specifications

4-Cycle Single Cylinder Engines	Model ABN	Model AKN
Bore	2½"	2⅞"
Stroke	2¾"	2¾"
Piston Displ. (Cu. In.)	13.5	17.8
HORSEPOWER		
1800 R.P.M.	2.5	3.6
2200 R.P.M.	3.1	4.5
2600 R.P.M.	3.7	5.3
3000 R.P.M.	4.2	5.9
3600 R.P.M.	4.6	6.2
No. of Piston Rings	4	
Fuel Tank Cap.	1 Gal.	
Weight, lbs.	Net	Crated
Standard Engine	76	89

WISCONSIN MOTOR Corporation
MILWAUKEE 46, WISCONSIN
World's Largest Builders of Heavy-Duty Air-Cooled Engines

WRITE TO HARLEY SALES CO.
619 S. MAIN STREET, TULSA, OKLAHOMA
M & M BUILDING, HOUSTON, TEXAS
505 SOUTH MAIN ST., WICHITA, KANSAS
OIL FIELD DISTRIBUTORS FOR WISCONSIN ENGINES AND ALL TYPES OF UTILITY UNITS.

▸ **L. A. Dixon** was elected a director of the Rockwell Manufacturing Company at the last board meeting. He has been a vice president of Rockwell's meter and valve division since early 1948, and before that was president of the Pittsburgh-DuBois Company, manufacturers of tin gas meters, which is now a division of the Rockwell firm.

L. A. Dixon

▸ **J. A. O'Brien,** general manager of the industrial products division, has been named one of three new vice presidents of Johns-Manville Corporation. O'Brien joined Johns-Manville in 1915 in the company's sales promotion department. He later became a salesman, advancing to assistant manager of the oil industry department. He was made general manager of the industrial products division in 1946. The other vice presidents appointed were **Harold R. Berlin,** general manager of the J-M building products division, and **A. S. Elsenbast,** general manager of the J-M celite division. O'Brien, Berlin and Elsenbast were formerly vice presidents of Johns-Manville Sales Corporation, a J-M subsidiary. In their capacities as vice presidents, they will take an active part in the work of the new overall company Planning Board.

▸ **Paul S. Shirley** has been named chief development engineer, heavy machinery division, Nordberg manufacturing Company. Prior to joining Nordberg, Shirley was chief research engineer at Baldwin-Lima-Hamilton. Shirley graduated from Ohio State University in 1929 with a degree in mechanical engineering. Following his graduation he joined National Supply Company.

P. S. Shirley

▸ **Robert C. Byler,** advertising manager, for SKF Industries, Inc., Philadelphia, Pennsylvania died suddenly on March 27.

▸ **Henry R. Michel** has been appointed assistant to Andrew H. Phelps, vice president in charge of purchases and traffic for the Westinghouse Electric Corporation. In his new position, Michel will be assigned to the Washington, D. C., office of Westinghouse, with responsibility for all matters pertaining to purchasing as it is affected by government regulations. Michel was graduated from Montana State College in 1920 with a BS degree in electrical engineering. Immediately after his graduation, he joined Westinghouse in the time study and rate department of the East Pittsburgh Works. He was later transferred to the storekeeping and purchasing deprtment and was named assistant purchasing agent in 1927.

▸ **J. G. Brannon** who has been representing Rector Well Equipment Company, Inc., in Snyder, Texas, has been recently transferred by the company to Hobbs, New Mexico. Brannon, a native of Alexandria, Louisiana, graduated from the Louisiana Polytechnic Institute where he received a BS degree in mechanical and electrical engineering.

J. G. Brannon

CHECK THROUGH WITH Enardo

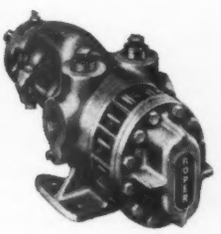
VAPOR CONTROL SYSTEMS

To conserve valuable vapors and keep out excessive air in your lease storage tanks write for information on the Enardo Vapor Control System. Consisting of an equalizer line . . . an automatic by-pass check valve on each tank and a diaphragm type in-line vent valve this system, in many cases, has paid for itself in 60 days. The equipment is so arranged that when the hatch on one tank is opened, that tank is automatically isolated from the rest, preventing vapor losses from other tanks.

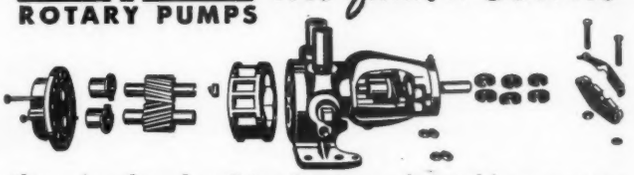
ENARDO

BOX 1647
TULSA, OKLA.

Savings that Pay Off...



ROPER ROTARY PUMPS are quick to Service



Above view shows how Roper Pumps are designed for easy accessibility. Not necessary to disturb pipe connections or mountings.

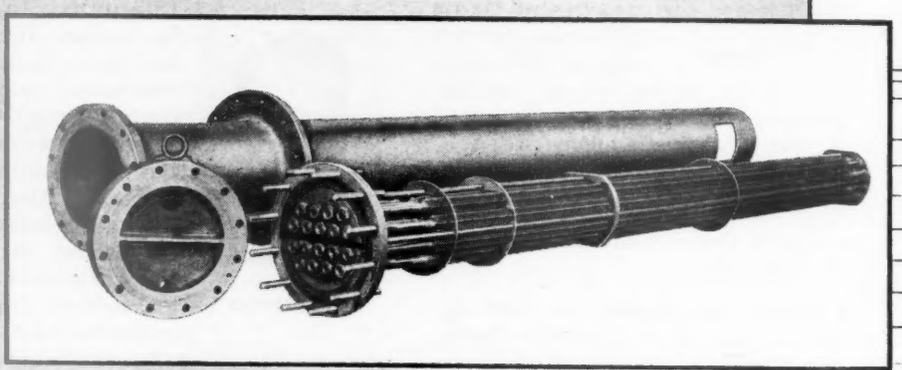
When an installation requires inspection because some destructive foreign element causes trouble, quick servicing design cuts down-time to a minimum and speeds the job. Furthermore, Roper replacement parts are interchangeable and available on all current models.

The exploded view above shows the detail of disassembly of a Roper Series F Pump . . . available for pressures up to 300 P.S.I. — built in 13 sizes up to 300 G.P.M.

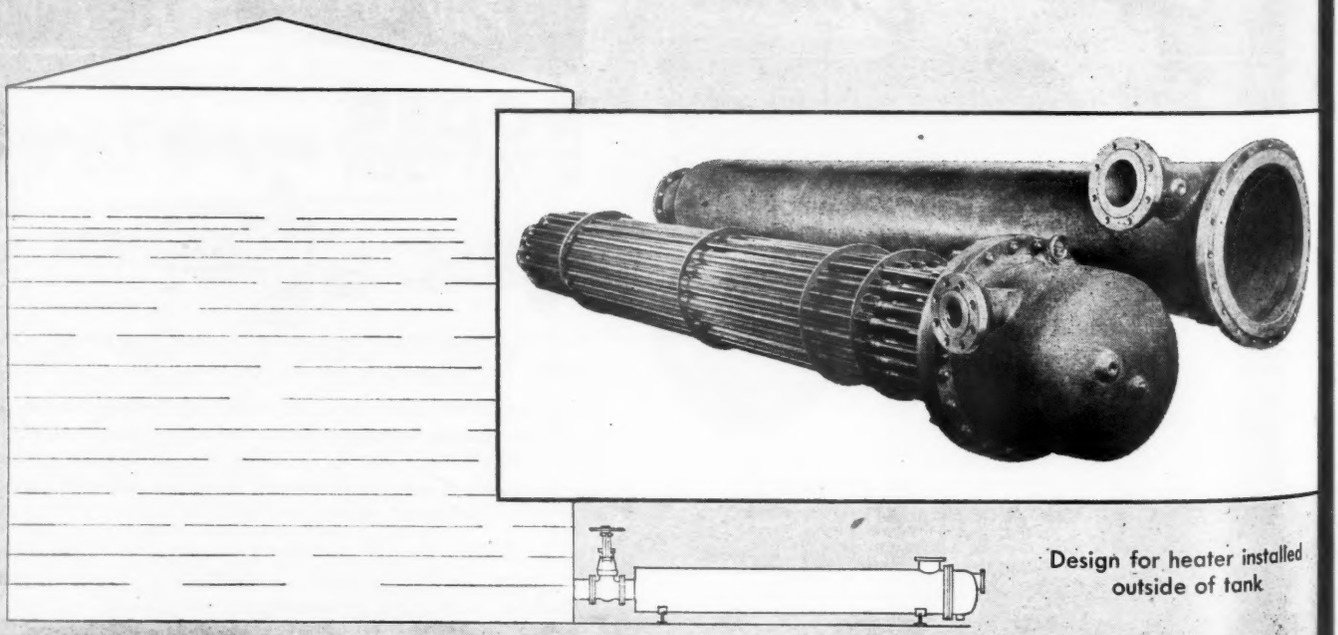
Write for Catalog Today
Capacities to 300 g.p.m.
Pressures to 1000 p.s.i.
GEO. D. ROPER CORP.
725 Blackhawk Park Avenue
ROCKFORD, ILLINOIS

ROPER Rotary Pumps

Why G-FIN..... for S



Design for heater installed partly within tank



Design for heater installed outside of tank

GRISCOM-RUSSELL: PIONEERS IN HEAT TRANSFER APPARATUS

Storage Tank Oil Heating

Here is the most practical unit for heating oil to be withdrawn from storage tanks.

The effectiveness, compactness, dependability and ease of inspection and maintenance of the G-Fin Storage Tank Oil Heater have made it widely used for every type and grade of viscous oil.

Some of the outstanding features of this heater are briefly outlined in the column at the right. These features are based on the unequalled G-R experience of more than 80 years in the design, manufacture, and operating results of many hundreds of thousands of heat transfer units. When you buy a G-Fin Storage Tank Oil Heater, you get authoritative ratings, skillful design which is exclusive in many respects, sturdy construction with accurate machine work, and proven performance.

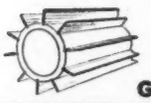
Write for bulletin describing these units in detail.

THE GRISCOM-RUSSELL CO.

285 MADISON AVE., NEW YORK 17, N. Y.

GRISCOM-RUSSELL

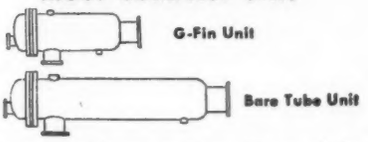
G-FIN STORAGE TANK OIL HEATER FEATURES



G-FIN EXTENDED HEATING SURFACE

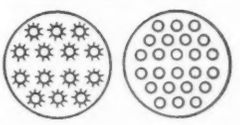
The G-Fin elements have eight times more heating surface than bare tubes of the same cross-sectional area and length.

MOST COMPACT UNIT



The increased heat transfer surface of the G-Fins means more heating surface in a given volume, and thus least heater space for a required duty.

FEWER TUBE JOINTS

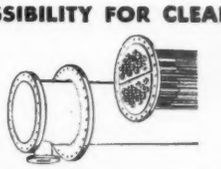


The small number of G-Fin heating elements results in a minimum of tube joints.

LEAKPROOF JOINTS

The conical ends of the G-Fin elements are seated in the tube sheet with accurately machined metal-to-metal joints held tight by lock-nuts.

ACCESSIBILITY FOR CLEANING



By removing lock-nuts at the tube sheet, individual G-Fin elements can be removed from the heater for inspection, thorough cleaning or replacement.

GR-261

GRISCOM-RUSSELL: PIONEERS IN HEAT TRANSFER APPARATUS

C. R. Rigby

F. S. Cornell

C. R. Rigby has been named group executive in charge of the A. O. Smith Corporation's plant at Houston, Texas. **F. B. Dunn,** former manager of the Houston plant, was placed in charge of personnel for both the Houston works and the company's entire southwest district administrative area, which covers 8 southwestern states. **F. S. Cornell,** manager of the A. O. Smith plant at Kankakee, Illinois, was appointed group executive Kankakee Works, the Eastern motor division at Tipp City, Ohio, and the company's heating division in Toledo, Ohio.

E. P. Roudebush, Roots-Connersville Blower Corporation, has been promoted to works manager, in charge of all production activities, **D. A. Johann** to sales manager, in charge of all sales and advertising activities, and **A. E. Caudle** to assistant sales manager. Roudebush is a native of Ohio and a graduate of Ohio State University. In 1944 he joined the parent company, Dresser Industries, Inc., coming to Roots-Connersville in 1950 as assistant to the vice president in charge of manufacturing.

Johann is a graduate of the Pennsylvania State College. He joined Roots-Connersville in 1946 as manager of the Chicago district office. Caudle is a graduate of Oregon State College. He joined the Roots-Connersville organization in July 1946 as chief application engineer.

Gene Madsen has been promoted to Los Angeles Basin sales manager for H. C. Smith Oil Tool Company, it was recently announced. Madsen has been active in a sales and service capacity with the company for the past 10 years. Prior to his new post he was branch manager at Newhall. Madsen will make his headquarters at the company's main office and plant at Compton, California.

Gene Madsen

Edgar Clinton Johnston, Sr., nationally known pioneer oilman, died recently at his home in Longview, Texas. Victim of a stroke, he was 52 at the time of his death. Edgar Johnston was a member of the oil-famous Johnston family which began drilling in the Spindletop field 50 years ago and has drilled more than 2000 producing wells, including the world's largest. Besides heading the oil company which bears his name, he was a partner with his brother, M. O. Johnston, prominent oil tool manufacturer, in Johnston Enterprises with plants at Greggton, Texas, and Los Angeles, California.

Frank R. Hunter has been named manager of a new branch office of Allis-Chalmers' general machinery division in Wichita, Kansas. An employee of Allis-Chalmers since 1940, Hunter has been a sales representative in the company's Kansas City district office since 1942. He is a mechanical engineering graduate of Kansas State College.

Guy F. Williams, Tulsa, Oklahoma, has been promoted from assistant sales manager to sales manager, oil field products division of Dowell Incorporated. Williams, who has been with Dowell since 1936, was named assistant sales manager in 1946. He has been in Tulsa since 1947 working with product sales. Before coming to Tulsa, he served with Dowell as a treating engineer in Mount Pleasant, Michigan; Seminole and Great Bend, Kansas.

Guy F. Williams

V. A. Kelly, Fluid Packed Pump Company, has been promoted to division engineer for North and West Texas. He was formerly district salesman at Snyder, Texas. **Herb Risner,** formerly with the American Iron and Machine Works, has joined Fluid Packed Pump Company's California sales force with headquarters at the company's Los Nietos plant.

J. Murray Walker, Export Sales Engineer for the Lane-Wells Company, is visiting most of the oil producing areas of South America and Mexico. Walker's tour will enable him to assist petroleum personnel in their applications of Lane-Wells' services and to introduce new products and developments. He has been with Lane-Wells for 14 years, serving in both the operations and sales departments.

D. L. Jerman

H. N. Simms

D. L. Jerman has been appointed district supervisor of gas products and Nordstrom valves used in the gas industry by Rockwell Manufacturing Company. Jerman joined Rockwell as a sales engineer in 1937 after receiving his education at Dean Academy and Columbia University.

Howard N. Simms has been appointed director of welding development and quality control of Black, Sivalls and Bryson, Inc. The company is a manufacturer of welded products for the oil, gas, and chemical industries. Simms will be responsible for the supervision of welding methods and procedures and the establishment and maintenance of quality control of all welded products. Simms has been associated with Black, Sivalls and Bryson, since 1936.

Eleanor E. Perks has been appointed advertising manager of Pennsylvania Flexible Metallic Tubing Company, Philadelphia. She will direct the advertising and public relations programs on Penflex metal hose products. Mrs. Perks had previously been engaged in sales promotion and sales analysis capacities for the company.

Paul B. Baird has been advanced to manager of standard pipe sales for The Youngstown Sheet and Tube Company. He succeeds Glenn W. Christopher who died recently. **Carl T. Selander** of Chicago, western representative for standard pipe products for the last year, has been promoted to assistant manager of standard pipe sales with headquarters in Chicago. Baird joined Youngstown Sheet and Tube in 1925 as a clerk in rod and wire shipping. He was appointed assistant manager of standard pipe sales April 1, 1950. Selander joined the company in 1935. He was appointed western representative for standard pipe sales at the Chicago office in March 1950.

James E. Goff, who joined Oil Well Supply Company in 1938, as a clerk in the Centralia, Illinois, store, has returned to that store as manager. All of his service with "Oilwell" has been in the Illinois district.

New Machinery and Supplies

Use reply card to procure promptly complete information and prices of products described here in brief.

Circle corresponding letter or letters on reply card.

A—OIL FILTER CARTRIDGE

Wisconsin Motor Corporation, in collaboration with Wix Accessories Corporation, has announced the development of a super filter, especially designed to match the lubrication system of the V-type 4-cylinder Wisconsin air-cooled engines. This new filter adds many extra horsepower hours of dependable service to the life of the engine by keeping the oil free from dirt, filings, and sludge—acid that accumulates in the crankcase. Called the Micro-Fine oil filter cartridge, it is a combination of virgin cotton and plastic impregnated wood cellulose. Wisconsin Motor Corporation.

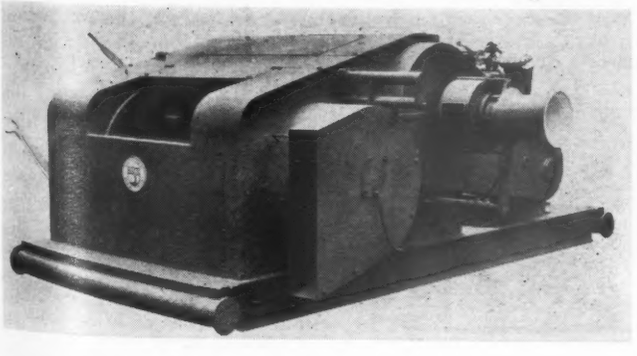
Circle letter A on reply card.

B—DRILLING RIG

For shallow drilling, medium depth servicing and workover jobs, a new Ideal Type T-12 drilling rig has been announced. The new rig, designed for 120 input horsepower, will normally be considered for drilling in the 1500 to 3000 ft depth range and for servicing and workover jobs in the 3000 to 6000 ft range. The T-12 rig is adaptable to trailer or truck mounting. One of the design features is the engine-mounted hydraulic torque converter drive augmented by two draw works speed ratios to the drum and rotary table. This high and low speed selection, combined with torque converter characteristics provides an efficient utilization of available engine power for all drilling requirements. National Supply Company.

Circle letter B on reply card.

Ideal Type T-12 drilling rig.



C—WELL TESTING UNIT

A compact portable well testing unit with a 24 in. OD x 6 ft S. to S. by 600 psi WP horizontal oil and gas separator, with oil meter and pilot loaded oil dump valve has been announced. Welded gas run is equipped with facilities for metering gas and has diaphragm type gas back pressure valve for maintaining constant pressure on the unit. Oil and gas outlet tie-in line is on the unit to permit rejoining the oil and gas after metering, if desired. Rolo Manufacturing.

Circle letter C on reply card.

D—PIPE LOADER

It takes only 17 seconds for the Pridy straight lift pipe loader to pick up one or several joints of pipe, place the load on a truck or gondola, and return to position for another lift. The number of joints per load will vary, depending upon the size of the pipe. The device is power-driven and hydraulically operated by remote control. The Pridy will lift a maximum load of 4000 lb to any height up to 11 ft 6 in. Control of all phases of the loader's work cycle is accomplished by means of control cords attached to a four-way valve on the loader. Republic Supply Company of California.

Circle letter D on reply card.

E—ROPE CARTON

For bulk buyers especially, a new size rope carton should prove of extreme interest. Of the same design and retaining all of the advantages of the company's other cartons, this third size carton measures 13 in. wide by 11 in. high, holds 600 to 1600 ft of rope, depending on size. It is said that the attractive, octagonal carton not only serves to keep the rope factory fresh and clean but may be used as a handy storage unit for unused portions of the coil. New Bedford Cordage Company.

Circle letter E on reply card.

F—LIQUID LEAK STOPPER

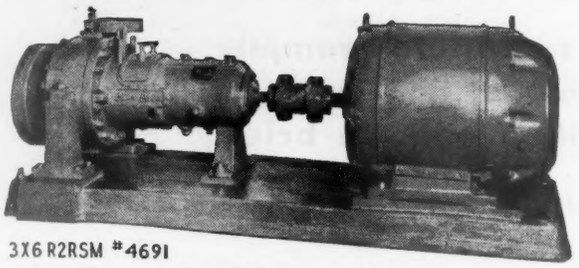
A new product was developed recently called Dasquik. Dasquik is a purple liquid developed to stop direct leaks against hydrostatic pressure without removing the pressure. This product has an initial setting time of 15 seconds and a final setting time of 30 seconds. Due to these rapid setting qualities of Dasquik, it is recommended for pressure leaks and pressure seepages only. It is claimed that Dasquik will stop direct leaks in 30 seconds without removing the hydrostatic pressure even if a 30 lb head of pressure is prevalent. Dasco Company, Inc.

Circle letter F on reply card.

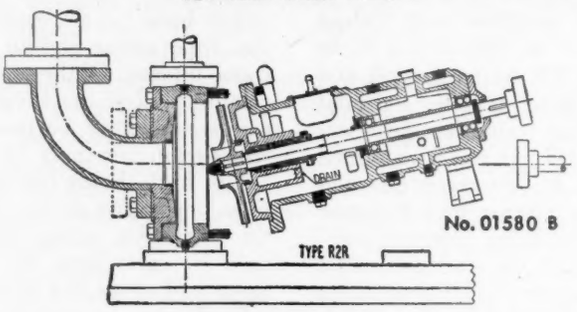
The Pridy pipe lifter loads truck in only 17 seconds.

DEAN BROTHERS PUMPS INC.

Type R2R Centrifugal Process Pumps



Type R2R Process Pump



Type R2R Process Pump

DISASSEMBLY: The Type R2R process pumps can be disassembled without disconnecting the suction and discharge piping. By first removing the spacer from the spacer type coupling, and unbolting the casing from the cradle the entire cradle and complete rotating element can be removed without disturbing the suction and discharge piping.

OPERATING RANGE; Type R2R, Heavy duty, process pumps are available in eighteen different sizes, enabling our engineers to furnish units specially designed and constructed for the particular work to be performed.

Capacities: 50 to 2000 Gallons per minute. **Heads:** Up to 400'. Speeds: 900 RPM to 4000 RPM.

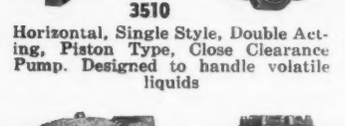
BUILDERS OF OUTSTANDING PUMPS SINCE 1869

CENTRIFUGAL and RECIPROCATING PUMPS

Close Coupled Centrifugal Pump

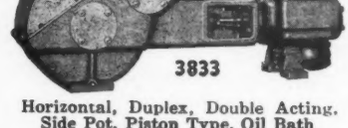
Horizontal, Single Style, Double Acting, Piston Type, Close Clearance Pump. Designed to handle volatile liquids

Pedestal Mounted Centrifugal Pump



Horizontal, Duplex, Double Acting, Side Pot, Piston Type, Oil Bath Power Pump

Double Pedestal Bearing Centrifugal Pump



Durable Duplex Packed Piston Pattern Steam Pump, Side Pot Type

ESTABLISHED 1869

DEAN BROTHERS PUMPS INC.

INDIANAPOLIS IND.

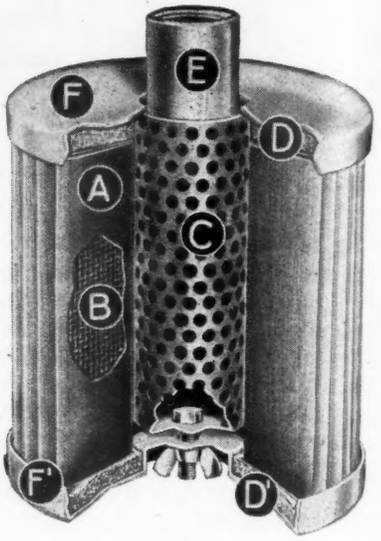
323 W TENTH ST.

Branch Offices: NEW YORK, N. Y., HOUSTON, TEXAS

Representatives in Principal Cities

G—HYDRAULIC FILTER

A new Staynew hydraulic filter, recently announced by Dollinger Corporation, Rochester, New York, is designed for use wherever dirty liquids



are collected and re-circulated. The new filter is suited for application on lathes, mills, shapers, planers, drills, conveyors, plastic molding machines, hydraulic presses and on many other types of cutting tools and hydraulically operated machines. There are only three major parts—lower end plate, insert and combined supporting tube, and upper end plate with threaded outlet sleeve.

Circle letter G on reply card.

H—RELEASE VALVE

A simple, well constructed, and altogether basically sound safety automatic pressure release valve is being offered to the oil industry. The control of high pressures is essential in many petroleum operations if dangerous consequences are to be avoided. The safety automatic pressure release is manufactured in two models — the 2-in. Nominal, for use on well drilling rigs and pumping units of all types, and the geophysical model for use on mud pumps such as are employed on shot hole and shallow core rigs. In their respective fields they are ideal for the protection of pumps, rotary hose, pipe, pipe fittings, and other machinery and equipment. The releasing member in the new valves is a plastic disc that disintegrates as soon as the maximum desired pressure is exceeded, causing an immediate pressure drop. The disintegration takes place inside the valve so that there is no danger to workmen. Grant Oil Tool Company.

Circle letter H on reply card.

I—TRACTOR SHOVEL

Newest "Payloader" tractor-shovel announced by The Frank G. Hough Company is the Model HY. This addi-

tion to the "Payloader" line has a 1¼ cu yd bucket and is available with 60 hp gasoline or diesel power. Engine is at the rear over the drive wheels for maximum tractive effort and capacity, and the operator is put up where he has a clear view in all directions and of the working area. Frank G. Hough Company.

Circle letter I on reply card.

J—ELECTRONIC RECORDING

A technique for recording simultaneously both the radioactivity and rock strata resistance in underground drilling operations and for other industrial and scientific applications has been developed. The new system consists of an electronic recording instrument for obtaining, in a single operation, data of great value in searching or drilling for oils, minerals, and water, it was reported. Previously separate measurements have had to be taken for two sets of data by making two "passes," one up and one down. Now a two-pen electronic recorder enables drillers to get the same results at greater speed and with a saving in manpower. The simultaneous recordings of the new device requires only one recording "pass," permitting speedy withdrawal of an entire electrode from a well. Minneapolis-Honeywell Brown Instrument Division.

Circle letter J on reply card.

K—LIFT TRUCKS

Shorter length, shorter width and narrower turning radius are features of the new, modern 2000 lb capacity fork lift trucks now being manufactured by The Buda Company. These two new fork lift trucks are available in a 24 and 15 in. load center. A new design single gear shift lever mounted on the steering column, a full front vision instrument panel with a complete set of gages, and a 9¼ in. diam clutch that is easily replaceable in 30 min without removing transmission are additional features of the new Buda 2000 lb capacity fork lift trucks. The Buda Company.

Circle letter K on reply card.

Always in Contact!

—with RCA 2-WAY RADIO

MORE COVERAGE

Users' tests prove that it covers greater distances.

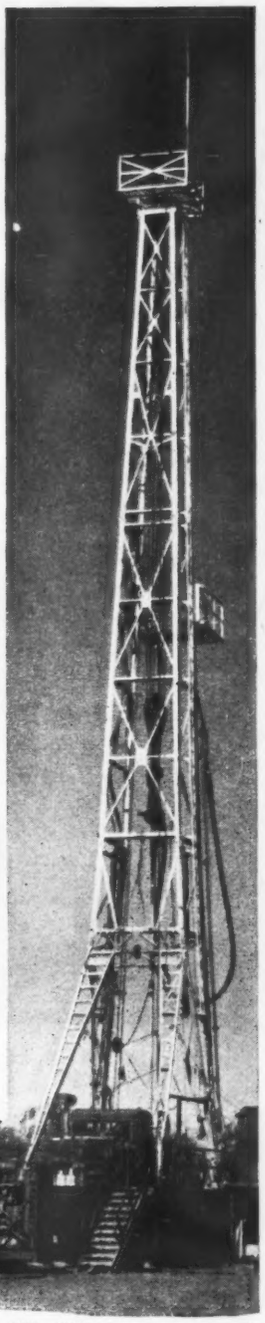
GREATER RELIABILITY

Rugged construction stands up under hard usage.

EASIER TO INSTALL AND SERVICE

Mobile unit is not bulky. It's easy to work with. It mounts directly on floor or wall. In cars it mounts on fire wall, on back-seat shelf, in trunks. In trucks, it mounts on wall of driver's compartment, in the freight section, in side lockers.

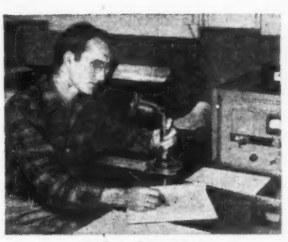
- **Use RCA "CARFONE" for the 152-174 MC band**
- **Use RCA "FLEETFONE" for the 30-50 MC band**



In vehicles

On remote location

Occupies small space. Leaves trunk compartment free for other equipment



At headquarters

For additional information, write: Dept.Q-152, RCA Engineering Products, Camden, N. J. (In Canada, write: *RCA Victor Company Limited, Montreal.*)

RCA ENGINEERING PRODUCTS, Dept. Q-152
Camden, N. J.

Please send me new brochures giving vital facts about RCA 2-way Radio.

Name_____

Company_____

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RCA RADIO CORPORATION of AMERICA

A Big Forward Step In The Measurement and Transmission of Flow

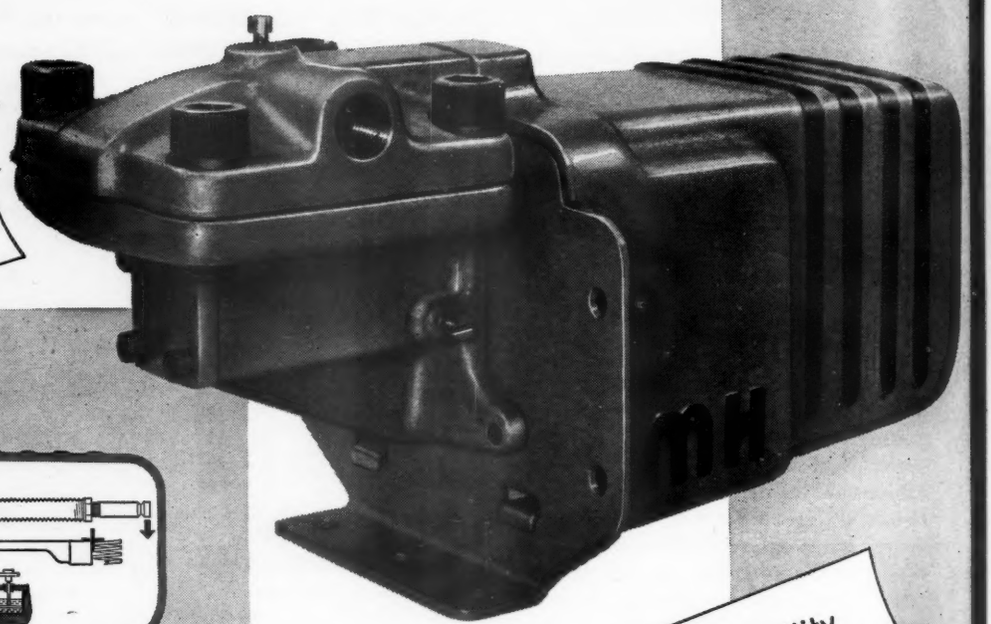
INTRODUCING *the New*

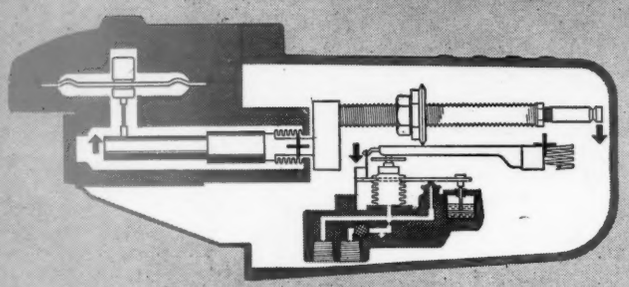
BROWN DIFFERENTIAL CONVERTER

(pneumatic-balance flow transmitter)

Easy Field Calibration –without water column

No Strainers Required





Functional schematic cross-section of the Brown Differential Converter . . . showing its utilization of the pneumatic-balance principle.

Easily Cleaned

Wide Rangeability –in one unit, 20 to 200″ H_2O

Fast Speed of Response

Easy to Install

No Mercury or Seals

AFTER long and rigorous testing in the field, the Brown Differential Converter is ready to set new high standards of simplicity and precision in the measurement and transmission of flow.

Operating on the pneumatic-balance principle, this compact and lightweight unit converts differential pressure at the orifice into a proportionate output air pressure which is a measure of flow. Range is continuously adjustable, from 0-20 to 0-200 inches of water. All adjustments are easily and simply made, without special tools or extra parts.

Applicable to a wide range of continuous processes, the Brown Differential Converter is the forerunner of an entirely new series of pace-setting developments made possible through Brown *Creative Instrumentation*. For detailed information write for a copy of new Catalog 2281 . . . and call in our local engineering representative for a discussion of your process needs. Offices in more than 80 principal cities of the United States, Canada and throughout the world.

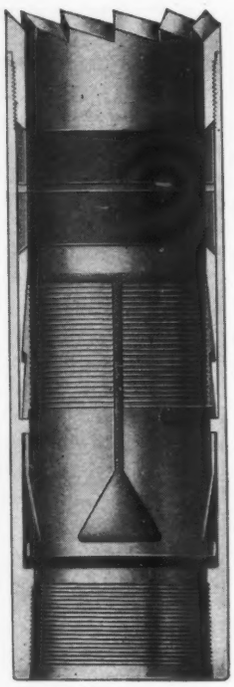
MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, 4475 Wayne Ave., Philadelphia 44, Pa.

MINNEAPOLIS **Honeywell**

BROWN INSTRUMENTS

L—CASING BOWL

The S. R. Bowen Company has recently placed on the market the packer type Bowen releasing casing bowl for use in wells where casing difficulties are encountered. The standard procedure is to make a cut with an internal cutter in the casing immediately below the damaged area and to pull the casing from the hole. The damaged portion of the casing string is then replaced with good casing. A Packer casing bowl is then installed on the bottom end and lowered over the casing in the hole. When upward pull is exerted, the tapers on the cone contract the slips into secure engagement with the casing and the cone bears against and compresses the lead Packing into a leak-proof seal around the casing. S. R. Bowen Company.



Circle letter L on reply card.

M—PNEUMATIC CYLINDERS

The B-50 series of pneumatic cylinders for throttling control service, are said to consist essentially of a new design of "O" ring sealed pneumatic cylinder with a piston positioner integrally mounted in the head plate. The cylinder itself is a bucket-type cylinder of cast aluminum. A one-piece piston is fitted with a graphite-impregnated "O" ring. Head plate and piston stem are also "O" ring sealed, eliminating head bolts and gland packing. The positioner is integrally mounted on the head plate, and takes its position by means of a contact spring riding on the piston. Conoflow Corporation.

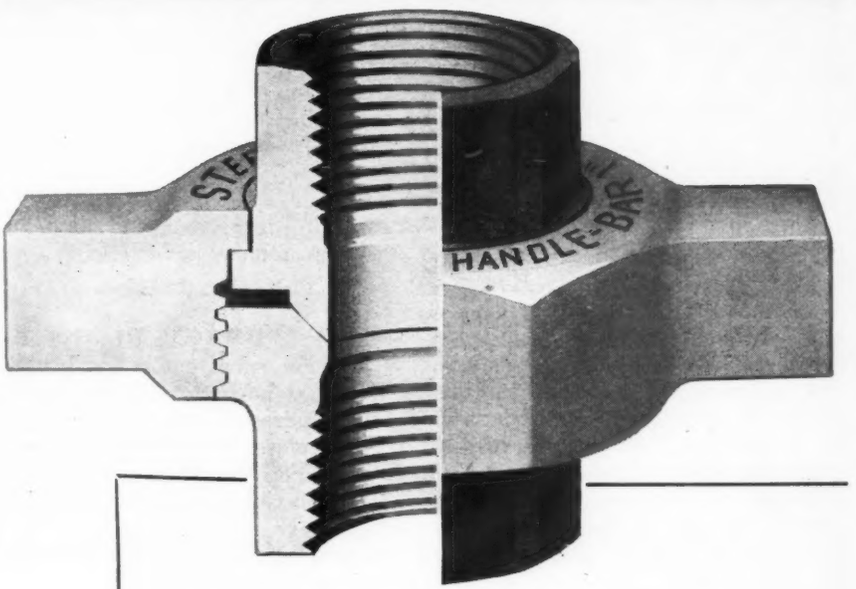
Circle letter M on reply card.

The Tool Pusher's Best Friend

HANDLE-BAR

REG. U.S. PAT. OFF.

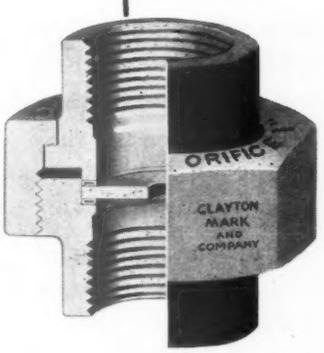
Forged Steel Unions



HANDLE-BAR 4000 TEST

REG. U. S. PAT. OFF.

HANDLE-BAR Unions are precision built with features that insure trouble-free performance. Hot forged from A. I. S. I. 1023 killed steel. Modified Acme threads in the nut. Nut threads permanently lubricated with Udylited Cadmium to permit ease in making and breaking. Steel to steel or bronze to bronze seats. Furnished Black or all Rust-proofed. Pressures to 3000 lbs.



ORIFICE

REG. U. S. PAT. OFF.

ORIFICE forged steel unions are recommended for flow control of steam, oil, ammonia, chemicals, water, gas, and air. Furnished with 18-8 stainless steel orifice plate and two steel-jacketed asbestos gaskets. Pressures to 3000 lbs., and temperatures to 900°.

Write Dept. P for illustrated catalog or refer to listings in Composite Catalog pages 3140-3141, Refinery Catalog page 538, and Chemical Engineering Catalog pages 980-981.

ORDER BY TRADE NAME FROM YOUR LOCAL JOBBER

ORIGINATORS AND PIONEERS OF STEEL UNIONS SINCE 1912

CLAYTON MARK & COMPANY

1900 DEMPSTER STREET • EVANSTON, ILLINOIS

N—CONTROL VALVE

A valve that combines the advantages of a powerfully actuated control valve and the versatility of a handwheel valve is now available. A handwheel-valve is mounted on the under side of the single seated valve body. When automatic control is desired the handwheel valve is opened fully causing no complications. During start-ups or instrument repair periods the handwheel provides positive manual control without changing valves. The handwheel may also be used as an adjustable limit stop for the automatic control valve plug. Annin Valve Company.

Circle letter N on reply card.

O—RESIN CEMENT

As a result of ten years of research in an attempt to develop a castable conductor of electrical current, Atlas Mineral Products Company, Houston, Texas, has succeeded in producing a new and novel resin cement called Conductoplast. Conductoplast may be cast in almost any form and exhibits practically no voltage drop when used as a conductor. It can be readily plated, it has a tensile strength of 1500 psi, a compression strength of 15,000 psi, and excellent adhesion to ceramic materials. As part of the development of Conductoplast, Atlas research chemists have also developed a non-conductor called Resistoplast. This product has much the same properties as Conductoplast except that it does not conduct current.

Circle letter O on reply card.

P—CHECK VALVES

A recent introduction of a new line of ultra-sensitive check valves for very low pressure applications was announced recently. Designated as the 119 series, this new valve is based on the firm's patented "Circle-Seal" principle, and is similar in design to their tried and proved line of standard check valves. The new low pressure valve is normally manufactured in brass or aluminum, with other materials available to customer order. Cracking pressure is 4 to 8 in. water column. James-Pond-Clark.

Circle letter P on reply card.

Q—DIAPHRAGM PUMPS

A new, small pump has just been added to the %Proportioneers% line of diaphragm pumps having "See-Thru" plastic reagent heads. The new "Pee-Wee," or midget Chem-O-Shot, has a maximum capacity of only 2 cc per stroke and is designed to fill the growing need for a compact, inexpensive, trouble-free pump for either continuous or intermittent feeding of water treating chemical solutions and slurries against pressures up to 50 psig. Two designs are available — Model E, an electrically actuated unit and Model H, a hydraulically actuated unit. %Proportioneers, Inc.%

Circle letter Q on reply card.

R—POCKET-SIZE COMPUTER

A pocket-sized computer that quickly and accurately tells the proper non-ferrous or stainless steel alloys to use for 142 corrosive situations has been developed. The computer is printed in 3 colors on heavy, long-lasting paper board. It operates simply, like a slide rule. The inner member is moved to line up the corrosive agent with a large arrow. A window then rates 13 non-ferrous and stainless steel alloys as excellent, good, fair, or not good for this agent. The computer will be mailed free to executives, engineers, metallurgists, and others interested in fastenings. H. M. Harper Company.

Circle letter R on reply card.

S—RADIO-TELEPHONE UNIT

A new portable FM two-way radio-telephone unit, which can be either hand-carried or back-packed, has been developed by Link Radio Corporation. The new pack set type 3035 is a complete portable assembly for operation in the 25-50 Mc very-high-frequency (VHF) band, while the pack set type 3036 is designed for operation in the 125-174 Mc very-high-frequency band. Weighing but 19 lb, these Pack Sets have a standard battery complement that provides as much as 50 to 100 hours of intermittent transmitting and receiving service. Link Radio Corporation.

Circle letter S on reply card.

T—CALIBRATED DIAL

A new calibrated dial for use with temperature regulators has been announced. The dial embodies several new features that assure quick, easy, and dependable temperature settings. It is time saving in that a quick turn of the dial to the desired setting is all the attention that is necessary. There is no need to wait for the equipment to heat up to find out if the setting is correct. The new calibrated dial is also said to provide protection against costly overheating caused by guess setting. The dial fits in place of standard adjusting sleeve, and is easily installed on Leslie Class T and Class M type regulators already in service. Leslie Company.

Circle letter T on reply card.

"... paid for themselves in the first year of operation"

The above statement was made by the Chief Engineer of a pipe-line station in Indiana concerning a set of Dura Seals installed on one of their pumps. These mechanical seals are on a main line Crude Oil service pump operating at 3600 RPM, having a suction pressure varying from 10 to 270 lbs., and a discharge pressure into the line averaging 700 lbs.

These single type Dura Seals have just completed five years of continuous operation without shut-down. The Chief Engineer said that he had figured up their previous cost of operation, including new sleeves once a year and labor involved, and that in comparison "... these Dura Seals have paid for themselves in the first year of operation."

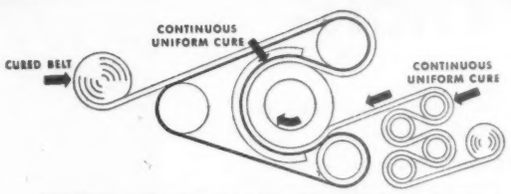
Learn more about the economy of Dura Seal service by writing the Durametallic Corporation, Kalamazoo, Michigan, asking for Bulletin No. PE-174.

OCS*

It's there even when you don't see it

...this Achilles Heel of Conventional Belts

ROTOCURE eliminates this common cause of Failure



SKETCH OF EXCLUSIVE ROTOCURE PROCESS

Although they often can't be detected with the naked eye, overcured segments or "Achilles' Heels" are present every 30 to 40 feet in belts cured by the flat press method. They occur because the vulcanization is *not* continuous due to overlapping. These press overlaps of 2" to 4" across the entire width of the belt get a double dose of curing. These segments make for costly operational weaknesses on the job and may result in early and complete failure of the belt.

* "Overcured Sections"—present every 30' to 40' in all belts made by the flat press method. *Only* Rotocuring eliminates this basic cause of belt failure.

BWH ROTOCURED belts are made differently—the *only* belts constructed by a continuous, endless curing process. Because press overlapping can't happen, overcuring is eliminated and flex life is improved by as much as 40%. Rotocure also eliminates mechanical distortion at the press ends . . . provides constant, uniform stretch . . . assures uniform abrasion resistant covers because one vulcanization and *only one* takes place. The end result is a better belt the first day you put it on . . . a more trouble-free belt day after day—a belt with MORE working days built into it! Ask your BWH distributor or write us direct.

Another Quality Product of

BOSTON WOVEN HOSE & RUBBER COMPANY

Distributors in all Principal Cities

PLANT: CAMBRIDGE, MASS. • P. O. BOX 1071, BOSTON 3, MASS., U. S. A.

BWH

DEPENDABLE RUGGEDNESS

U—VALVE ACTUATORS

Designed for the operation of gate valves, plug valves, dampers, diaphragm valves, butterfly valves and sluice gates, and developed as a standard product, is a line of valve actuators, just introduced by Ledeen Manufacturing. Ledeen valve actuators are basically Ledeen cylinders, equipped with brackets, valves, controls, and couplings to make them suitable for almost any type of operation required. They can be adapted to any make, size, and type of valve; to operate against any line pressure; to work on any fluid medium, and with any pressure available. They can be arranged for on-and-off or positioning service. Ledeen Manufacturing.

Circle letter U on reply card.

New hand pump.

V—DIFFERENTIAL CONVERTER

A compact and lightweight transmitter, designed for more sensitive measurement and control of fluid flows in many industrial processes, has recently been developed. The new unit, called a differential converter, has a continuously adjustable range from 0-20 to 0-200 in. of water (differential pressure) and provides this 10 to 1 change of range with no change of parts. Field calibration of any range is possible by the use of scale-type weights that eliminate the need for a water column. Operating on the pneumatic-balance principle without mercury, the Differential Converter employs an accurate weigh-beam system in which the differential pressure, due to fluid flow at the metering orifice, is continuously balanced by a pneumatic pressure. Minneapolis-Honeywell Regulator Company.

Circle letter V on reply card.

W—HAND PUMP

Newly designed hand pumps in five series of 7, 10, 14, and 28 gal per minute capacity, each in several models, are now in production. The new line, known as Series 210, 404, 414, 828, and 807, is available in models as pump only; with suction and delivery pipes for drums and skid tanks; return drip-pan for barrel mounting; refueling hose and nozzle; floor stand for underground tanks; brackets for wall or floor mounting; and locking device. Blackmer Pump Company.

Circle letter W on reply card.

X—VACUUM PUMPS

It is now possible to design very large oil ejector pumps for large scale industrial application of high vacuum in the process industries, distillation products industries, a divison of Eastman Kodak Company, has announced. The principle of vapor ejection from a nozzle at supersonic velocity is the most efficient method known for maintaining vacuum in the range from 1 to 100 microns Hg, it has been found. Basically the properties of high-velocity stream flow are used to compress rarefied gas to pressures at which a mechanical pump can handle it efficiently. Eastman Kodak Company.

Circle letter X on reply card.

YOU GET GREATER FLEXIBILITY IN

NEMCO CONTROL STATIONS

"NEMCO" Class 441 Explosion-Proof, Heavy Duty Control Stations offer an unusual degree of flexibility.

They are furnished in five sizes of enclosures to provide for the mounting of from one to five control devices. As a result, the sequence of controls can be varied to suit practically any scheme of operation. Different devices which can be mounted in any one of the unit positions include:

Push-button station; selector switch; pilot light; mushroom cap; emergency break-the-glass station; maintained contact start-stop interlocking pushbutton (requires 2-unit station); etc.

"NEMCO" Heavy Duty Control Stations can be furnished for either surface or flush mounting. Designed for Class 1, Group D Hazardous Locations, they are made from high tensile gray iron which is produced in our own foundry.

WRITE TODAY FOR NEW 10-PAGE BULLETIN No. 441

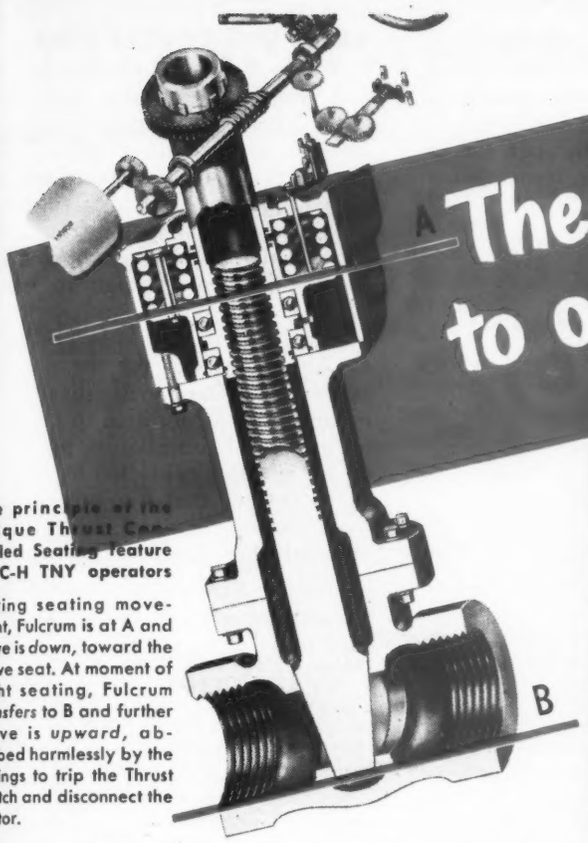
Size 1 enclosure is for one control unit such as pushbutton, pilot light, selector switch, etc. Sizes 2, 3, 4 & 5 also furnished.

Shown above is Size 5 enclosure which will accommodate five different control units. Write for Bulletin No. 441.

NELSON Electric MANUFACTURING CO.

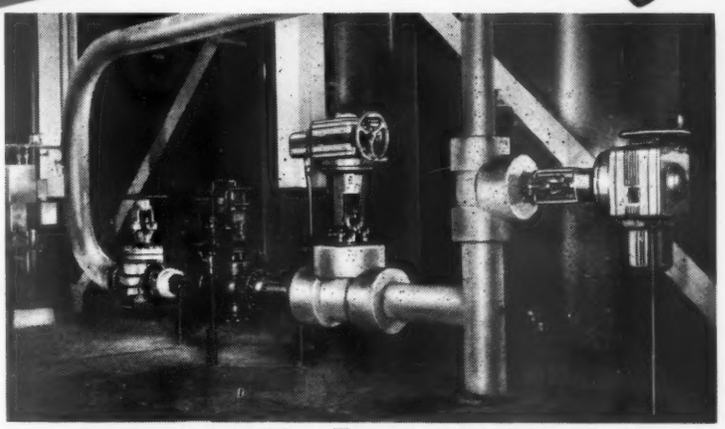
217 N. Detroit St. TULSA, OKLAHOMA Telephone 2-5131

The Safe Sure Way to operate valves *Automatically*



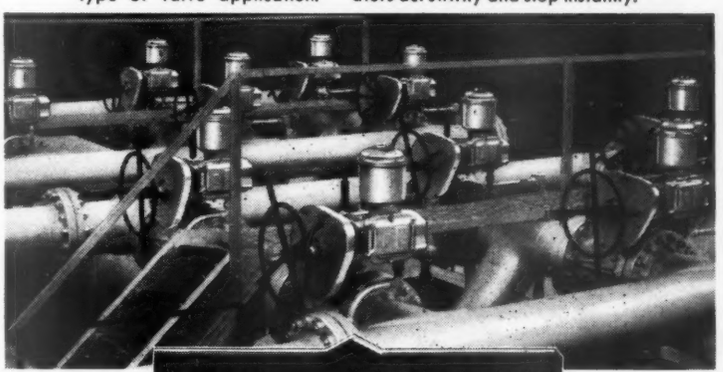
The principle of the unique Thrust Controlled Seating feature of C-H TNY operators

During seating movement, Fulcrum is at A and drive is *down*, toward the valve seat. At moment of tight seating, Fulcrum *transfers* to B and further drive is *upward*, absorbed harmlessly by the springs to trip the Thrust switch and disconnect the motor.



Experience behind C-H Type TNY operators dates back to 1900, embraces every type of valve application.

For valves which do not seat, such as the plug type valves, C-H B2 automatic declutching valve operators act swiftly and stop instantly.



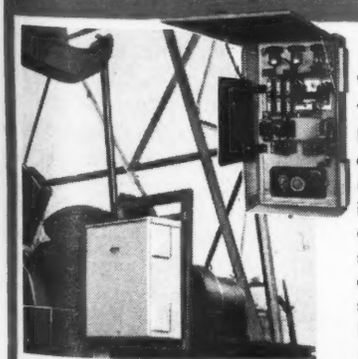
THE problem of mechanized valve operation is the problem of *correctly* seating the valve. The danger is that either the disc is not completely seated, or that the driving force is not cut off soon enough with the result damaging stresses are set up throughout the assembly.

But Cutler-Hammer *Thrust Controlled* Valve Operators not only seat *all* valves under *any* circumstances exactly as they *should* be seated, but because of their ingenious design maintain that degree of tight seating without variation through expansion and contraction of valve parts under the extremes of heat and cold.

It will pay you to investigate Cutler-Hammer Motorized Valve Operators for any and every valve need. CUTLER-HAMMER, Inc., 1459 St. Paul Avenue, Milwaukee 1, Wisconsin.

CUTLER-HAMMER
VALVE CONTROL
C-H

OTHER CUTLER-HAMMER PRODUCTS FOR THE OIL AND GAS INDUSTRY



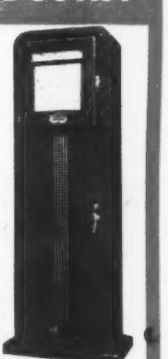
Long-lasting control that "schedules" oil well pumping

This Cutler-Hammer Motor Control Device built to the rigid requirements of tough oil country service automatically starts pump going and shuts it down in synchronization with oil well capacity or in conformity to operating schedule. You can set up any sequence of day and night operation, set it to skip certain days. Bulletin 9589D-21 tells all about this amazing pumping control. Send for free copy.

Know what you are buying, selling, giving away

These "gas counting" instruments tell you accurately

Cutler-Hammer Calorimeters . . . standard wherever gas is bought or sold—actually count the B. t. u.'s per cubic foot of the gas you are sending or receiving. Accurate within 1%. They also write a continuous 24-hour a day permanent record so you know at all times exactly what is going through your piping system . . . for accurate accounting and billing, and for accurate control of gas heating value. Free booklet "Where Experience Counts" tells all about C-H B. t. u. Control.



NEW!
CHROME-CLAD
MEZURALL
"10-FOOTER"
TAPE-RULE
No. C-9210

CHROME-CLAD BLADE
EASIER READING
LONGER WEARING
SELF-ADJUSTING HOOK
REPLACEABLE BLADES

With the new *Mezurall "10-Footer"* Tape-Rule you can save time and insure greater measuring accuracy on all types of shop work beyond the capacity of regular 6 or 8-foot Tape-Rules. Check all these features:

- **Non-glare *Chrome-Clad* satin finish blade will not crack, chip, peel, or corrode.**
- **Durable Black Markings that stand out sharply against chrome white background.**
- **Self-Adjusting End Hook that permits accurate butt-end and hook-over measuring.**
- **Replaceable blades. Patented safety catch simplifies changing blades.**
- **Improved, Heavily Plated Case with inset side plates in attractive red and white.**

A "natural" for measuring large steel sheets, plywood, linoleum and for countless other important industrial uses.

Your Supply House has them . . . specify No. C-9210 10-ft. Chrome-Clad Mezurall. Also available with nickel plated blade, specify No. 9210.

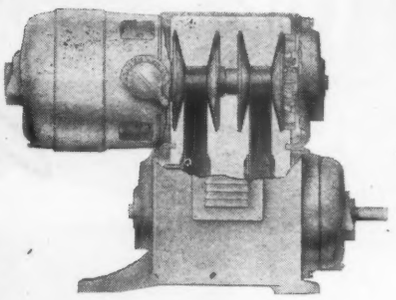
96-C

BUY LUFKIN TAPES • RULES PRECISION TOOLS

THE LUFKIN RULE CO.
SAGINAW, MICH. • New York City • Barrie, Ontario

Y—HEAVY DUTY MOTORS

A line of extra heavy duty motors for variable speed with ratings as high as 50 hp has been developed. To carry the heavy load through the internal speed changing transmission,



engineers have incorporated dual varibelts, thus distributing the load so that no undue strain is imposed. To counterbalance belt load, tension control known as Autotaut has been designed. This principle avoids the disadvantages of variable center drives or extra flexing of belts over idlers. A calibrated spring is employed to maintain pressure between the two halves of the driven varidiscs and the sides of the belt. U. S. Electrical Motors, Inc.

Circle letter Y on reply card.

Z—PIPE FITTINGS

Gruvagrip Fittings, a complete new line of malleable fittings for grooved pipe, including L's, T's, adapter nipples, crosses, laterals, bull plugs, and reducers, have been announced. The new fittings come in sizes ¾-12 in. and withstand the same working pressures as Gruvagrips, the grooved pipe couplings widely used in petroleum, and other industries. New Gruvagrip Fittings are light, easy to handle, easy to install. Inside walls of Gruvagrip Fittings are true circles, smooth and gently curved to prevent turbulence and frictional losses. Gustin-Bacon Manufacturing Company.

Circle letter Z on reply card.

AA—OIL FIELD CHAINS

The complete line of Rex and Baldwin Rex oil field chains are described in a new bulletin. A detailed presentation of the Baldwin Rex "BA" (Baldwin assembly) riveted oil field assembly is given in the first part of the book. With the "A" assembly, any length of chain can be made up in a jiffy. No longer is it necessary to cut chain to length. Also included in the book is a description of Rex oil field chains, including Rex offset side bar roller chains and Rex A.P.I. chains. Chain Belt Company.

Circle letter AA on reply card.

AB—PIPE PROTECTORS

A new lightweight expander cone and transfer sleeve has been developed. These engineered tools are an integral part of the quickest known method for installing casing and drill pipe protectors. The highly polished expander cone is "spun" from a steel alloy, which makes it light and easy for the installation man to handle, making the job fast and easy. The function of this cone is to provide an expanding surface for the protector as it is transferred hydraulically from its unstretched condition to the transfer sleeve. An installation paste used on all surfaces contacted by the protector insures that the rubber slides freely on the cone and sleeve. Patterson-Ballagh Company.

Circle letter AB on reply card.

AC—PRESSURE GENERATION

The Milton Roy "airROYmetric" pressure generator has been used in broad field of hydrostatic test applications. The unit is combined with a group of specially designed simplified controls to develop test pressures up to 25,000 psi, using ordinary plant air supply in the pump cylinder. Each of the pumps develops a discharge pressure ratio range of at least 6 to 1. permitting single pump use for applications requiring various test pressures. Individual units may be custom made for specific applications between 25 psi and 25,000 psi. The pressure generator has use in the hydrostatic testing of boilers, forgings, castings, tubing, pipes, and piping systems, pressure gages, valves, vacuum pumps, dryers, and high pressure hose, among others. Milton Roy Company.

Circle letter AC on reply card.

AD—SMALL DRILLS

A new heavy-duty air-operated small drill designated as the 9DBW-28A, was announced recently. The new Cleco drill has many features normally found on larger drills such as: Stub tooth gear train for sturdiness and long life, built-in lubricator for positive lubrication, a sealed spindle bearing, and a chuck guard for safety. The manufacturer states the 9DBW-28A answers the need for more powerful, longer life drill that is easy to handle in close quarters. The small size, 5¾ in. overall length and only $\frac{13}{16}$ of an inch from the side to the center of the spindle contributes to easy operation in close quarters. Cleco Division of the Reed Roller Bit Company.

Circle letter AD on reply card.

Trade Literature

Publications will be sent free.

AE—REFRACTOMETER, AMPLIFIER

Control of chemical composition and/or concentration through use of the precision-dow robomatic refractometer is described in Honeywell Data Sheet 11.0-4. Details and illustrations concerning the operation, theory, and applications of the apparatus are explained in this 4-page pamphlet. A second bulletin describes the Brown Servo amplifier system. Consisting of a converter, amplifier and two phase fractional horsepower motor, this system is especially adaptable to the detection and correction of error signals and operation of null-balance systems. Minneapolis-Honeywell Regulator Company, Brown Instrument Division.

Circle letter AE on reply card.

AF—SEAL TUBING

A new 8-page bulletin on Spang-seal tubing is now available to the public. The new tubing was developed to meet the need for leak resistant tubing for the commercial economical production of oil wells. The Spang-seal joint tubing has half as many threaded connections and therefore half as many points for possible leakage as threaded and coupled tubing. This is accomplished by the use of an integral type connection with Standard API threads on both male and female ends, thus eliminating couplings. National Supply Company.

Circle letter AF on reply card.

AG—ANNUAL BULLETIN

"Caterpillar Products" is the title of a new 40-page booklet recently issued by Caterpillar Tractor Company, Peoria, Illinois. This booklet, published annually, contains a complete listing with pictures and brief specifications of all but two of the current line of "Caterpillar" products, 81 in all.

The list of additions ranges from tractors to tool bars and includes the following: the DW20 four-wheel and DW21 two-wheel Tractors, Nos. 8U and 8SR Cable Bulldozers, Nos. 20 and 21 Scrapers, No. 42 Tool Bar, No. 27 Cable Control and the W20 Wagon. Caterpillar Tractor.

Circle letter AG on reply card.

AH—TUBING STEELS

Technical data valuable to engineers associated with the design, fabrication and application of stainless tubing is offered in a new 4-page bulletin published by Babcock and Wilcox. Known as Technical Bulletin 19, it contains condensed data on analyses, oxidation resistance, thermal treatment and mechanical, electrical and physical properties on 10 of the most popular austenitic and ferritic stainless tubing steels. The Babcock and Wilcox Tube Company.

Circle letter AH on reply card.

AI—VISCOSITY MEASUREMENT

A new catalog now ready for distribution describes Viscorator instruments, which, it is claimed, provide an instantaneous method for determining viscosity values for industrial processes. Featured is a new development in this field represented by the auto-sampling Viscorator instrument, which has a constant differential pressure regulator as an integral part of its design. This provides a constant meter sample flow rate (regardless of line fluctuations) in a simple self-contained unit. Fischer and Porter Company.

Circle letter AI on reply card.

AJ—SAFETY VALVE

An illustrated bulletin on the new Ross safety valve is now available. This valve is said to establish new safety standards for industrial press and similar applications because of the elimination of all springs and the use of a clapper type solenoid. The bulletin, Ross No. 304, includes a cross sectional view and installation data. Ross Operating Valve Company.

Circle letter AJ on reply card.

AK—FOUNDATION STRUCTURES

An unusual 24-page brochure on drilled and poured foundation structures has just been published. Types and applications of foundation structures, pressure grouting, drainage, de-watering, shoring, and sub-surface soil exploration are illustrated and described in case history fashion. Also included are tables prepared for the assistance of engineers in estimating drilled and poured foundation piling and caissons. Casey and Case Foundation Company.

Circle letter AK on reply card.

AL—HEAVY EQUIPMENT

A 4-color operator's handbook printed in comic book style and prepared especially for heavy equipment operators is now being distributed by Caterpillar Tractor Company, Peoria, Illinois. The 32-page book contains information on the operation of bulldozers, scrapers, rippers, and cable controls, plus additional material on high speed hauling, loading, and grade stakes familiarization. The book shows many of the techniques in earthmoving operation.

Circle letter AL on reply card.

AM—SYNTHETIC RUBBER COATINGS

A new brochure on the uses and methods of application of synthetic rubber resin based coatings was made available to the public recently. Also covered in the 8-page booklet are machinery enamels, damp-wall enamels, stucco-masonry coatings, and scuff-free floor finishes. Fifteen years of study of industry requirements for a corrosion control coating and 6 years of intensive laboratory and field work in proving these products are back of this publication, the company reports. Casey and Case Coating Company.

Circle letter AM on reply card.

AN—DRILLING HEAD

Guiberson Corporation has published a new manual on the installation, operation and maintenance of its Type "J" rotary drilling head. Completely detailed procedures for changing rubbers and wash pipes are outlined and illustrated for the first time. Lubrication requirements of the Type "J" are thoroughly illustrated and specified. Power and attachments are presented in detail. Guiberson Corporation.

Circle letter AN on reply card.

AO—OIL, WATER COOLER

A new design of oil and water cooler with several advantageous features is described in a bulletin recently published. The unit, known as the LK-Fin Cooler, is distinguished by the use of helically-finned heat transfer elements instead of conventional bare tubes. Diagrams show comparisons of length and number of tubes and size of units for equivalent heat transfer surface. The bulletin also describes and illustrates the design details that provide most effective heat transfer, permit free expansion of the tube bundle, prevent interleakage, and leakage to the outside. Griscom-Russell Company.

Circle letter AO on reply card.

AP—DRILLING RIG

The new Ideal Type T-12 drilling rig, rated at 120 input horsepower and for shallow drilling, medium depth servicing and workover jobs, is described in a new bulletin recently published. Features of design, construction and operation, dimensional line drawings, performance curves, and specifications are included in this 8-page bulletin. National Supply Company.

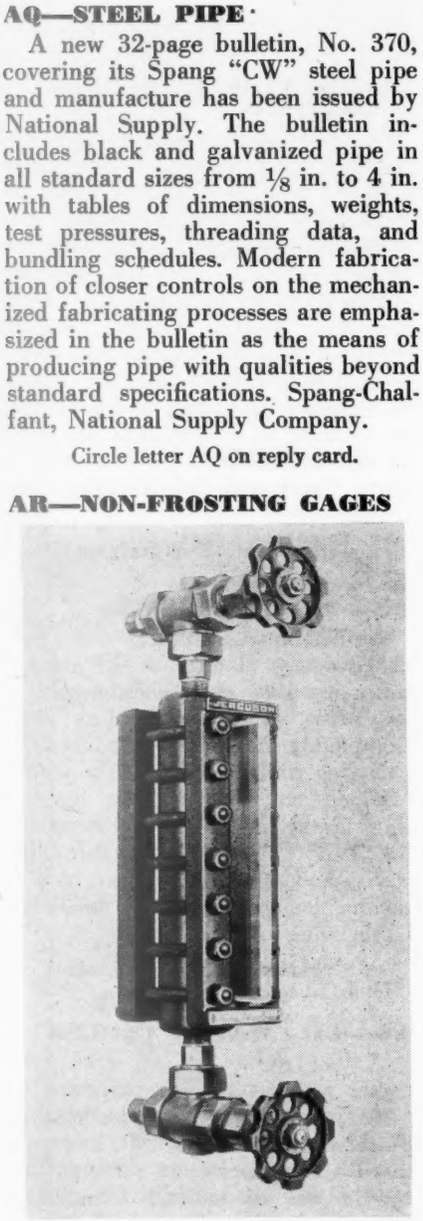
Circle letter AP on reply card.

AQ—STEEL PIPE

A new 32-page bulletin, No. 370, covering its Spang "CW" steel pipe and manufacture has been issued by National Supply. The bulletin includes black and galvanized pipe in all standard sizes from ⅛ in. to 4 in. with tables of dimensions, weights, test pressures, threading data, and bundling schedules. Modern fabrication of closer controls on the mechanized fabricating processes are emphasized in the bulletin as the means of producing pipe with qualities beyond standard specifications. Spang-Chalfant, National Supply Company.

Circle letter AQ on reply card.

AR—NON-FROSTING GAGES



The Jerguson patented gage glass extension, which prevents frost from forming over the vision slot; thereby permitting quick, accurate level reading of low temperature and low boiling point liquids has been announced.

Literature on this as well as data units on other non-frosting models is available. Jerguson Gage and Valve Company.

Circle letter AR on reply card.

AS—TENSION LINKAGE

An informative handbook for designers of tension linkages has just been released. The term "Tension Linkage" as used in this book describes any chain application in which linear movement of the chain is not continuous in direction. The predominating feature of a tension linkage is that the chain need not be an endless belt as in a power transmission drive. Numerous examples of tension linkages are shown and described in this bulletin. Baldwin Duckworth, Chain Belt Company.

Circle letter AS on reply card.

AT—ZEOLITE SOFTENER

A new bulletin, numbered Publication 4520, on sodium zeolite water softeners, headed "Cochrane Zeolite Softeners Featuring the Cochrane Hydromatic Single Control Valve" is now available. This publication gives a detailed explanation of the sodium zeolite softening process containing a definition of terms employed in this description, the data necessary for laying out a zeolite water softening plant, the factors governing the sizing of such equipment, the selection of zeolite material and a description of both siliceous zeolites and non-siliceous zeolites and a description of the four steps of operation of a zeolite softener. Cochrane Corporation.

Circle letter AT on reply card.

AU—OIL WELL TUBING

National Supply has announced a new 8-page bulletin, No. 378, covering its new Spangseal oil well tubing. The bulletin, illustrated in color, emphasizes design features in relation to solution of tubing leakage problems and includes specifications for standard sizes. Spang-Chalfant Division, National Supply Company.

Circle letter AU on reply card.

AV—INTEGRAL FINTUBES

Brown integral "one-piece" fintubes are described in a new 8-page bulletin No. 511. The booklet lists the range of sizes and the materials in which they are available; illustrates the wide variety of heating and cooling applications in which they are used and gives three pages of engineering data. These include design curves and a tabulation showing the comparative outside surface areas provided by different sizes of bare pipe or tubing, and longitudinally finned pipe or tubing. Brown Fintube Company.

Circle letter AV on reply card.

AW—STEAM TRAP

The V. D. Anderson Company, manufacturers of Super-Silvertop steam traps, Cleveland, Ohio, has recently revised its 36-page catalog, "Solving Steam Trap Problems," which contains information for engineers, contractors, and maintenance men who specify, install, or service steam traps. This new catalog contains revised specifications and capacities on the complete line of steam traps, Anderson float traps, air release valves, and pipe line strainers. V. D. Anderson Company.

Circle letter AW on reply card.

AX—PUMP DRIVES

Bulletin 4907 on Pacific-Western right angle vertical pump drives gives application data, engine RPM and ratio tables for both the speed increasing and speed reducing type units designed and manufactured by Western Gear Works. These new pump drives are for the specific application of horizontal type prime movers to vertical shaft pumps. A wide range of sizes are offered including sizes larger than 200 hp at 1:1 ratio and 720 rpm. Western Gear Works.

Circle letter AX on reply card.

AY—DRIVE GROUPS

National Supply's Ideal Type "B" sectional drive groups, designed for use primarily with engines in the 250 to 400 hp range, and featuring Airflex engine clutches, are described in Bulletin No. 1-377 recently published. A 2-color, 8-page booklet that points out structural as well as operating features of Ideal Type "B" drive groups, the bulletin contains pictures and diagrams of 2, 3, and 4-section units. National Supply Company.

Circle letter AY on reply card.

AZ—RUBBER CONSERVATION

The tremendous problems now facing industry in conserving rubber and increasing production with present equipment, has resulted in the publication of a booklet titled "Conservation Maintenance Plan". Included in the "CMP" program are a handbook, wall charts, and monthly bulletins. This data contains hundreds of illustrations and suggestions on how to select, install, and maintain conveyor belting, flat transmission belting, V-belts, hose, and packing. By adopting this plan, it is claimed, plants will be able to prolong the life of industrial rubber products. Quaker Rubber Corporation, division of H. K. Porter Company, Inc.

Circle letter AZ on reply card.

BA—INDUSTRIAL CLEANING

How solvent detergents provide outstanding benefits in hundreds of industrial cleaning applications is discussed in a 24-page illustrated booklet recently issued. The booklet reports upon the many classifications of cleaning in which solvent detergents are being successfully used today to perform such typical tasks, for example, as: Removing oily films, smuts, cuttings from steel in metal fabrication processes; removing carbonized oil and grease deposits encountered in the repair and maintenance of transportation facilities; to make cleaning more practical by pre-cleaning to remove extra-heavy deposits in a preliminary operation, especially applicable where metal parts are thickly coated with oils, grease, and solid-particle soils. Oakite Products, Inc.

Circle letter BA on reply card.

BB—SLUSH PUMP

The new Ideal Type E-500 power slush pump with 7¾-inch maximum fluid cylinder liner bore and 14-inch stroke and a maximum recommended working pressure of 3500 psi, is covered in new Bulletin No. I-371, issued by The National Supply Company, Toledo, Ohio. The bulletin has 8 pages describing features of design and lubrication with illustrations of the pump, certain parts, and dimensional line drawings.

Circle letter BB on reply card.

BC—NEEDLE VALVES

Publication of a 4-page folder describing the entire Kerotest line of forged steel, union bonnet needle valves for high pressures and corrosive services, has been announced. The valves described are available in ⅛, ¼, ⅜, ½ and ¾ in. sizes, for working pressures up to 4000 lb at 150 F. Forged for greater strength and shock resistance, they are manufactured in three different materials: Carbon steel and stainless steel 12-14 chrome — both with hardened heat treated stem of type 420 stainless steel; and with 18-8 mo stainless steel throughout. Kerotest Manufacturing Company.

Circle letter BC on reply card.

BD—CENTRIFUGAL PUMPS

Describing and illustrating one of the broadest lines of general purpose pumps offered by any manufacturer, a new Peerless Pump bulletin has just been published. Peerless Fluidyne pumps are of the horizontal, end-suction centrifugal type and may be driven by electric motors in sizes from ¼ to 150 hp, affording a capacity range from 10 to 5500 gpm. Liquids can be pumped against heads up to 260 ft. Two types of pumps are offered in the line. One is a close-coupled electric motor driven pump, designated as the Peerless Type PE. The other, designated as the Peerless Type PB, is a bracket-mounted pump for driving through a flexible coupling, of V-belt, or flat-belt pulley. Fluidyne pumps may be installed and will operate in any position—vertical, horizontal or intermediate angle. Peerless Pump Division, Food Machinery Corporation.

Circle letter BD on reply card.

BE—FIRE BRICK

A new 4-page illustrated folder, entitled "JM-3000 Insulating Fire Brick", presents the economic advantages, industrial applications, and refractory properties of this product, the first insulating fire brick for sustained use at 3000 F. Physical and thermal characteristics are given in table form. An illustrated description highlights the use of these insulating fire brick in the construction of a slot type forging furnace. The folder also contains summarized information on accessory materials and other insulating brick. Johns-Manville.

Circle letter BE on reply card.

One source for ALL YOUR FIELD HOUSING NEEDS
Four rooms and bath with plenty of closet space. An ideal STURDYBILT home for a small family.
A specially designed loading warehouse using standard STURDYBILT 4' x 8' wall sections.
A five room and bath house with attached garage. As attractive and comfortable as any family could desire.
A special garage designed to accommodate passenger cars and large trucks. Made of Standard STURDYBILT sections.

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Prefabricated, Demountable Houses

phmi PREFABRICATED HOME MANUFACTURERS INSTITUTE

STURDYBILT HOUSES COMPLY WITH COMMERCIAL STANDARD CS125-45 OF THE NATIONAL BUREAU OF STANDARDS FOR PREFABRICATED HOMES

BF—CENTRIFUGAL COMPRESSORS

A new catalog on Clark centrifugal multi-stage compressors is now available. In addition to being a complete descriptive piece on Clark units, it includes an engineering section containing data and performance characteristics. Diagrams and charts in the booklet provide complete engineering data to allow an engineer to approximate the power requirements, rotative speed, and discharge temperature for most multi-stage centrifugal compressor applications. Clark Brothers Company, Inc.

Circle letter BF on reply card.

BG—MOTOR CONTROLS

A new bulletin describing polarized field frequency controls (standard interrupting capacity type) for synchronous motors has just been published. This 8-page, 2-color bulletin illustrates and describes in detail all the standard types of polarized field frequency synchronous motor controls for full-voltage, reduced-voltage, and part-winding starting. It is also replete with catalog-type data including ratings, weights, dimension drawings, wiring diagrams, layout drawings, etc. Electric Machinery Manufacturing Company.

Circle letter BG on reply card.

BH—REFINERY PRODUCTS

A new catalog has been published of refinery products U. S. Rubber manufactures for the oil refining industry. The catalog contains engineering data on the division's line of oil, gasoline, liquefied petroleum gas, water, steam, and air hose used in refinery operations. It also gives data on its various types of packing materials and expansion joints. In addition, a section is devoted to its new Uscolite thermoplastic pipe, the chemical resistance of which makes it particularly suitable of refinery work. United States Rubber Company.

Circle letter BH on reply card.

BI—ROCK DRILLS

Bulletin No. h-1200-B42 describing Worthington's WJ-45 and WJ-55 hand held rock drills is now available to the public. The single sheet, two-color bulletin describes both types of drills and carries a table of hand-held rock drill specifications. The WJ-45 drills are lightweight, all-purpose drills, weighing about 45 lb. They are available in air tube, water tube, blast rod types. The WJ-55 is a medium weight drill in the 55 lb class. It has the same features and embodies the same type of powerful rotation as the WJ-45.

Circle letter BI on reply card.

BJ—VALVE PRICE LIST

A new Jarecki valve price list is out. It contains information on sizes, materials of construction, and prices of the Jarecki line of valves. Included in the line are bronze valves and cocks, iron valves and cocks, iron and brass unions, expansion and swing joints. This price list is available to manufacturers, jobbers, contractors, etc. Jarecki valves are well-proportioned, properly designed, and constructed of metals of high tensile strength. Jarecki Valve Division, H. K. Porter Company, Inc.

Circle letter BJ on reply card.

BK—SCALE PREVENTION

A new bulletin recently published outlines the Velan process for the elimination of limestone crust formations in boilers and pipes. This is a positive action device and our trial offer with money back guarantee has not as yet been claimed upon. The results are achieved by a simple mechanism, which transmits extra high wave impulses to the liquid being treated—it is a continuous process and lime particles are crystallized and fall to the bottom of the container and are easily removed—no more shut downs for descaling, etc. Velan Engineering Company.

Circle letter BK on reply card.

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New and Renewal Subscriptions received prior June 1 will be entered at current rates, which were established to introduce PE's four separate editions.

The Petroleum Engineer

Box 1589—Dallas

BL—WIRE ROPE

A new, revised, and enlarged data book, combining valuable engineering information with an extensive catalog of the most complete line of wire rope and chain fittings was published recently. In addition to presenting detailed working characteristics of each product to remove guesswork in selecting the proper fitting, Laughlin has included tables and charts which make Catalog No. 150 a valuable reference book for engineers, architects, riggers, and safety directors. The Thomas Laughlin Company.

Circle letter BL on reply card.

BM—CONDENSER TUBES

Under the title of "Life Extension for Condenser Tubes", an extensively illustrated brochure that reports on long research done on causes of corrosion and means of combating them, as well as on the choice of condenser tube materials, has been published. Present restrictions on the use of copper and its alloys still further stress the importance of extending condenser tube life. Causes of corrosion are of several types, the report notes, and there is a great variety of miscellaneous influences, some of them subtle and difficult to trace. The report points out that Admiralty metal, long the standard for power plant condenser tubes, will work satisfactorily in the majority of installations, especially now that it has been made highly resistant to dezincification. But other alloys may be necessary in some instances to assure longer life and reduce maintenance and replacement costs. Revere Copper and Brass.

Circle letter BM on reply card.

BN—WELDING SPECIFICATIONS

The latest issue of "Valve Values," includes a table of welding end specifications for Edward cast steel valves, which is of value to valve specification writers, valve buyers, and pipe fabricators. This reference table, developed from specifications of the American Steel flange standard B16e of 1939, the ASA B31.1—1951 Code for Pressure Piping, the ASME Power Boiler Code for 1946 and Pipe Fabrication Institute Standard ES1—1948, is especially designed for removal from the company magazine for handy desk top reference. It contains diagrams of straight bevels for pipe wall thicknesses of 3/4 in. and less, and diagrams of U-bevels for pipe wall thicknesses of over 3/4 in. Edward Valves, Inc.

Circle letter BN on reply card.

BO—PIPE LINE FILTERS

With emphasis on the well-known staynew double action principle, a new 8-page file-size bulletin has been issued, which describes, illustrates, and gives applications and specifications for 75 filters, including pressure and vacuum types. The Staynew double action principle provides both mechanical separation and filtration. A scientifically shaped deflector cup directs the flow of air or gas together with entrained water, oil and other foreign matter to the walls of the filter housing, and thence downward at high velocity to the base. Installation views are shown of the new Series 600 filters, built for air pressures up to 6000 psi. Dollinger Corporation.

Circle letter BO on reply card.

BP—TESTING INSTRUMENTS

A 32-page bulletin has been issued listing both R.S. and Ac-Me testing instruments for the petroleum industry. Fully described are recording gravitometers with or without controller, dead weight gages, gas gravity balances, high pressure consistometers, moisture tester for gases, vapor pressure bombs, manometers, Yel-O-Bak thermometers, etc. Refinery Supply Company.

Circle letter BP on reply card.

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BOOKS

Chemistry of Hydrazine, *by L. F. Audrieth and Betty Ackerson Ogg. Published by John Wiley and Sons, Inc., 440 Fourth Avenue, New York 16, New York. Pages, 234. Price, $5.*

This book is a practical treatment of potentially useful hydro-nitrogen—*hydrazine,* its important characteristics, reducing properties, inorganic compounds, and a patent survey of its uses and applications. Emphasizing nitrogen chemistry as a distinct borderline field involving a knowledge of both organic and inorganic chemistry, the book discusses the relationship of hydrazine to some other hydronitrogens and its consideration as an ammono derivative, as well as qualitative identification and quantitive determination, and a survey of the actual and potential uses of hydrazine.

Natural Regions of the U.S.S.R., *by L. S. Berg, translated by Olga Adler Titelbaum. Published by The Macmillan Company, New York. Pages, 362. Price, $10.*

This book by the Dean of Soviet geographers describes all of the natural regions and zones of the vast U.S.S.R. First, it discusses the lowland regions—the tundra, the temperate forest, the forest steppe, the semi-desert, the desert, and the subtropical forest. Under these subdivisions are included the boundaries of the region, their general characteristics, climate, relief, and soils vegetation and fauna.

Translated by a graduate in geography and edited by specialists, this American edition contains 23 maps, a comprehensive glossary, an exhaustive index, and is profusely illustrated.

Geology of Southwestern Santa Barbara County, California, *by Olaf P. Jenkins. Bureau of Mines Bulletin 150. Pages, 84; 9 plates and book in cardboard box. Price, $5.*

This report covers an area typographically marked by the Federal Government in five 15-minute quadrangles comprising an area of 700 square miles, namely: Point Arguello, Lompoc, Point Conception, Los Olivos, and Gaviota quadrangles. The geology of the area is described in great detail and graphically shown on colored lithograph maps, which are accompanied by stratigraphic, structural, and physiographic diagrams. The economic minerals are also described and mapped, and three important oil fields—Capitan, Lompoc, and Zaca—are described.

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Discoveries of 1950, *by Frank J. Gardner, Five Star Oil Report. Pages, 24. Price, $15, non-subscribers; subscribers, $10.*

The primary purpose of this book is to provide an early resume of oil activity during the year just closed. Sections contain tables summarizing U. S. oil production, a record of the wells drilled in the U. S., a financial study of oil stocks in 1950 and a comprehensive list of discoveries in South Texas, Coastal Louisiana, New Mexico, East Texas, West Central Texas, North Texas, the Texas Panhandle, and the Texas Gulf coast.

The Marketing of Chemical Products, *by Robert S. Aries and William Copulsky, published by Chemonomics, Inc. 400 Madison Avenue, New York, N. Y. 149 pages. $3.*

First appearing in 1948, this book filled the need for a comprehensive and detailed text book on marketing, sales, and advertising aspects of the chemical process industries. A compilation and summary of the knowledge of almost 80 leading experts actually marketing chemical products, the volume covers market research, commercial chemical development, technical sales and advertising, and technical service in the chemical industry—all illustrated with actual case histories.

Statistical Engineering in the Chemical Process Industries, *by James R. Thomen, published by Chemonomics, Inc., 400 Madison Avenue, New York, N. Y. Pages, 48, Price, $2. First of a series.*

This monograph contains abstracted articles dealing with quality, experimentation, production control, reproducibility studies, design of experiments, analytical determinations, and testing processes applied to some phase of the chemical process industries, such as: Pulp and paper, petroleum, plastics, organic chemicals, inorganic chemicals, etc.

Technical Drafting Essentials, *by Warren J. Luzadder, published by Prentice-Hall, Inc., New York. Pages, 315. Price, $4.*

This book has been prepared to fulfill the need for a text in the technical field that will present the basic fundamentals of engineering drafting in accordance with sound pedagogy. It is altogether a student's handbook, and not a reference book, pursuing the idea that technical drawing is not a language that need be understood by engineers and draftsmen alone, but something that belongs to all persons concerned with production processes, as well as sales and service.

The Practice of Lubrication, *by T. C. Thomsen, published by McGraw-Hill Book Company, New York. Pages, 612. Price, $8.*

This revised edition of a technical engineering treatise provides a comprehensive coverage of the origin, nature, testing, selection, application, and use of all types of lubrication. The book takes up a number of typical lubrication problems, analyzes them, and points out how each problem can be solved. It covers the increased use and improvement of synthetic oils; outlines the lubrication of aero engines and aircraft accessories, and describes new solvent-refining processes.

Oil for the World, *by Stewart Schackne and N. D'Arcy Drake, published by Harper and Brothers, New York. Pages, 128. $2.50.*

The purpose of this book is to "bring to light the hidden parts of the career of oil." A brief introduction to the subject of oil, written for the general reader, is illustrated with maps, charts, and photographs. The significance of petroleum and petroleum products to human welfare and world economy, information about the important oil-bearing regions of the world, and how this vital natural resource is being made available, are all contained in the text.